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USAFOEHL REPORT

88-078EQ0025FEF

COMPLIANCE TESTING of GRISSOM AFB CENTRAL HEATING PLANT COAL-FIRED BOILERS 3 and 5, GRISSOM AFB IN

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June 1988

Final Report

USAF Occupational and Environmental Health Laboratory
Human Systems Division (AFSC)
Brooks Air Force Base, Texas 78235-5501

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This report has been reviewed and is approved for publication.

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19 ABSTRACT (Continue on reverse if necessary and identify by block number)

At the request of HQ SAC/SGPB, compliance testing (particulate Emissions) of coal-fired boilers 3 and 5 in the Grissom AFB Central Heating Plant was performed on 4-14 Mar 1988. The survey was conducted to determine compliance with Indiana Administrative Code, Title 325--Air Pollution Control Board, Articles 5 and 6. Results indicate that boilers 3 and 5 met particulate standards while exhausting through scrubber A. However, boiler 5 failed to meet particulate standards while exhausting through the bypass stack.

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I. INTRODUCTION

On 4-14 Mar 1988, a stationary source sampling survey for particulate emissions was conducted on coal-fired boilers 3 and 5 at the Grissom AFB Central Heating Plant, by the Air Quality Function of the USAF Occupational and Environmental Health Laboratory (USAFOEHL). This survey was requested by HQ SAC/SGPB to determine particulate emission compliance status with regards to Indiana Administrative Code, Title 325 - Air Pollution Control Board, Article 5, Opacity Regulations (325 IAC 5), and Article 6, Particulate Regulations (325 IAC 6). Personnel involved with on-site testing are listed in Appendix A.

II. DISCUSSION

A. Background

On 7 Nov 1986, the Director, Air and Radiation Division, U.S. Environmental Protection Agency (EPA), Region V, issued a notice of violation (NOV) to Grissom AFB for violation of 325 IAC 5, Opacity Regulations. The NOV was based on information submitted by the State of Indiana Department of Environmental Management and by the EPA. Observations indicated that oil-fired boiler 1 and coal-fired boilers 3 and 4 (boiler 5 was out of service during the State observations) were out of compliance with respect to visible emissions.

To demonstrate and maintain compliance with 325 IAC 5 and other rules set forth by the Indiana Air Pollution Control Board, EPA, Region V required Grissom AFB to: (1) conduct stack particulate emission testing on boilers 3, 4 and 5 (when operational) as specified in Title 40, Code of Federal Regulations, Part 60 (40 CFR 60), Appendix A, Reference Method 5; (2) determine visible emissions from boilers 1-4 and 5 (when operational) as specified in 40 CFR 60, Appendix A, Reference Method 9; and (3) request stack testing following future major modifications to the central heating plant.

B. Site Description

The Central Heating Plant operates a total of five boilers for steam production:

Boiler No / Manufacturer	Steam Capacity (lb/hr)	Year Installed	Fuel
1/Springfield Boiler Co.	40,000	1955	oil
2/Springfield Boiler Co.	40,000	1955	oil
3/Springfield Boiler Co.	40,000	1955	coal
4/E. Keeler Co.	40,000	1960	coal

Boilers 3 and 5 are spreader-stoker fired units with each having forced-draft and induced-draft fans and mechanical fly-ash collection systems. The purpose of the forced-draft fan is to supply air for combustion and that of the induced-draft fan is to maintain a negative draft condition in the furnace part of the boiler for combustion and removal of gases and to provide a positive static pressure at flue gas exhaust discharge points. The ash system pneumatically removes ash from bottom-ash hoppers, sifting hoppers and mechanical collector hoppers. Each unit is fitted with a steam-operated soot blower to remove fly-ash and soot from heat exchanger tubing. Boiler 5 is also fitted with an economizer to further increase operating efficiency by preheating the feed water using exhaust gas heat.

Air pollution control consists of individual multiclone dust collectors on each boiler and an optional wet scrubber common to the three coal-fired boilers. The multiclone dust collectors fitted on boilers 3 and 5 were manufactured by Western Precipitation Division - Joy Manufacturing Co. The collector on boiler 3 is a Model 9VM-10 and consists of 36 nine-inch diameter cyclonic collectors operating in parallel. The collector on boiler 5 is a Model 9VMU-10 and consists of 48 nine-inch diameter cyclonic collectors operating in parallel. Each unit is located in the boiler exhaust duct upstream of the induced-draft fan. Ash collected by the multiclones is carried by gravity to a hopper.

The exhaust effluent from each boiler is ducted to a common breeching and can be routed to the wet-scrubber or to a bypass stack. The scrubber is a double-alkali flue-gas desulfurization system using soda ash(sodium carbonate) in the scrubbing fluid and lime (calcium hydroxide) slurry for regeneration of the scrubbing liquid. The primary purpose of the unit is to remove sulfur from the flue gases; a secondary purpose is to remove particulates from the flue gases. The system has two identical scrubber units (A & B), each designed to handle 50% of the flue gases from the three coal-fired boilers. Each unit has a 5 ft diameter stack and terminates about 70 feet above the ground. There is no requirement at this time to use the scrubber system because of the low-sulfur coal being used by the plant. The bypass stack has a 5.5 ft diameter and terminates approximately 70 ft above ground level. The scrubber stacks and the bypass stack can be seen in Figures 1, 2 and 3. A flue gas flow diagram is shown in Figure 4.

C. Applicable Standards

The monitoring requirements, opacity regulations and particulate regulations are defined under 325 IAC 3, 5 and 6 respectively. Article 5 states that visible emissions shall not exceed an average of 40% opacity in 24 consecutive readings or 60% opacity for more than a cumulative total of 15 minutes (60 readings) in a 6-hour period.

Under 325 IAC 6, the maximum allowable particulate emission rate from the combustion of fuel for indirect heating facilities (which were existing and in operation or which received permits to construct prior to the effective date of 325 IAC 6, 26 Sept 1980) is determined by the following equation:

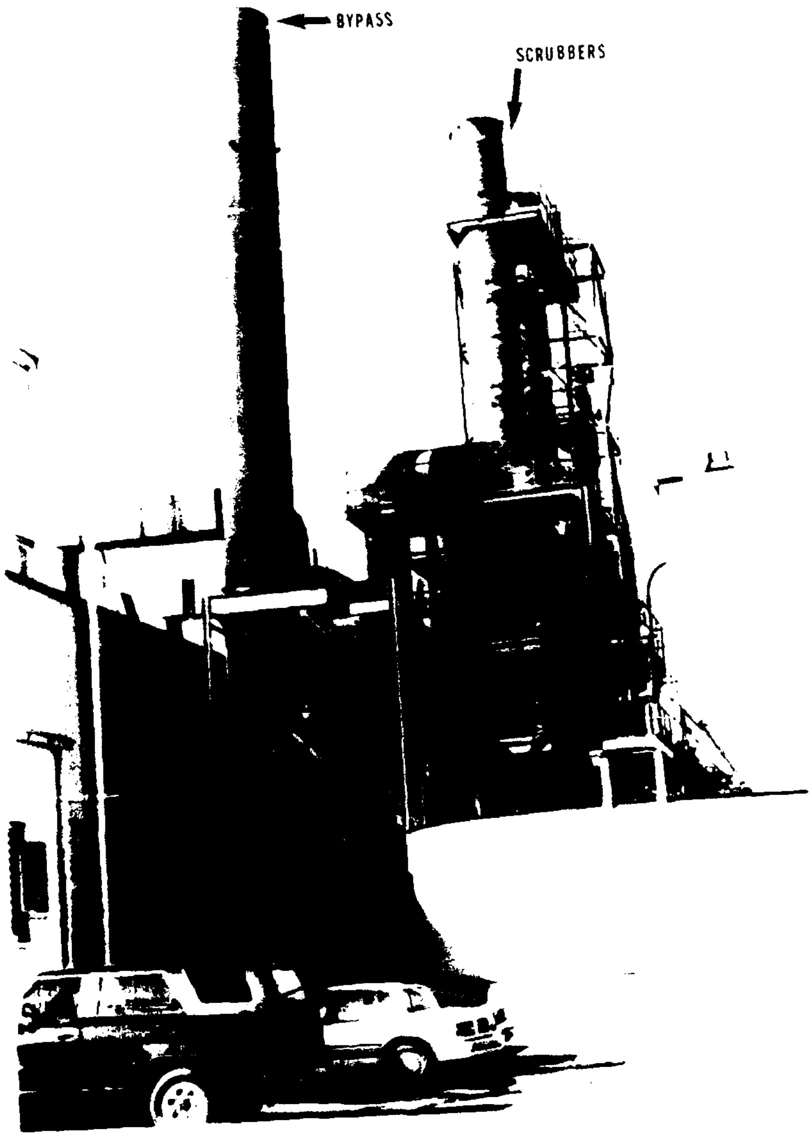


Figure 1. View of Scrubber and Bypass Stacks

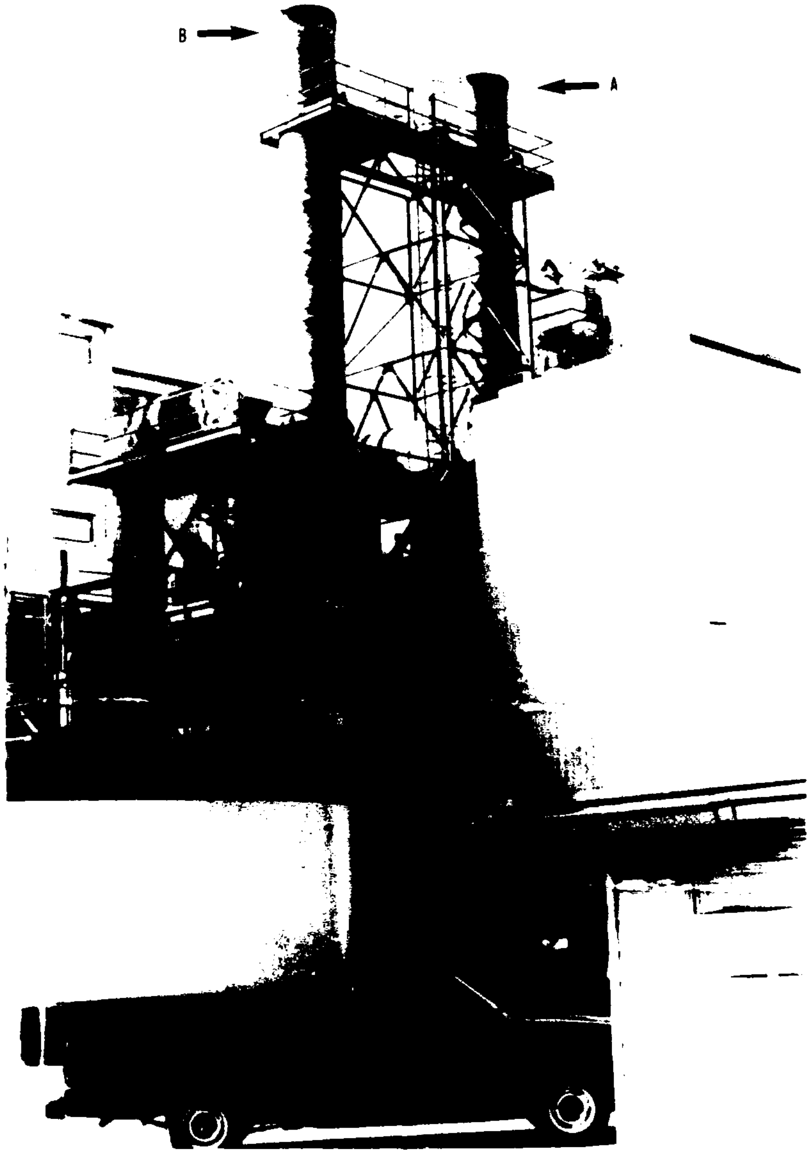


Figure 2. Scrubber A and B Stacks

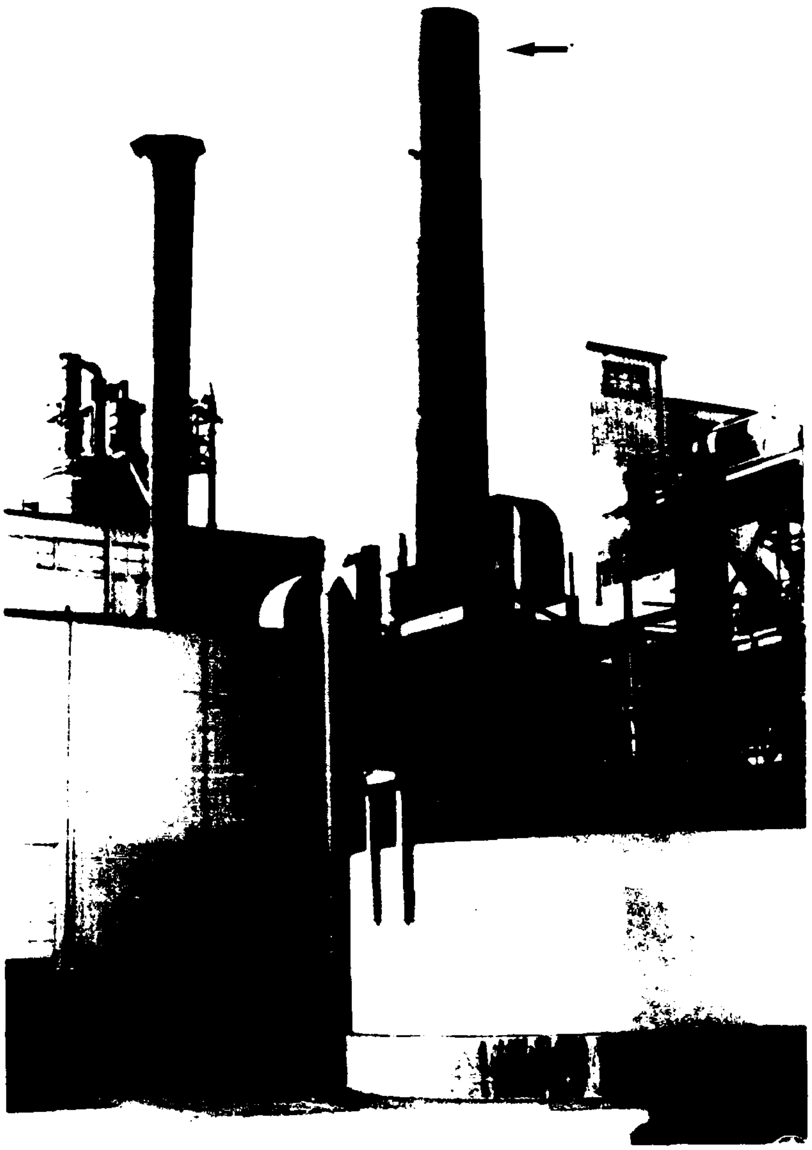
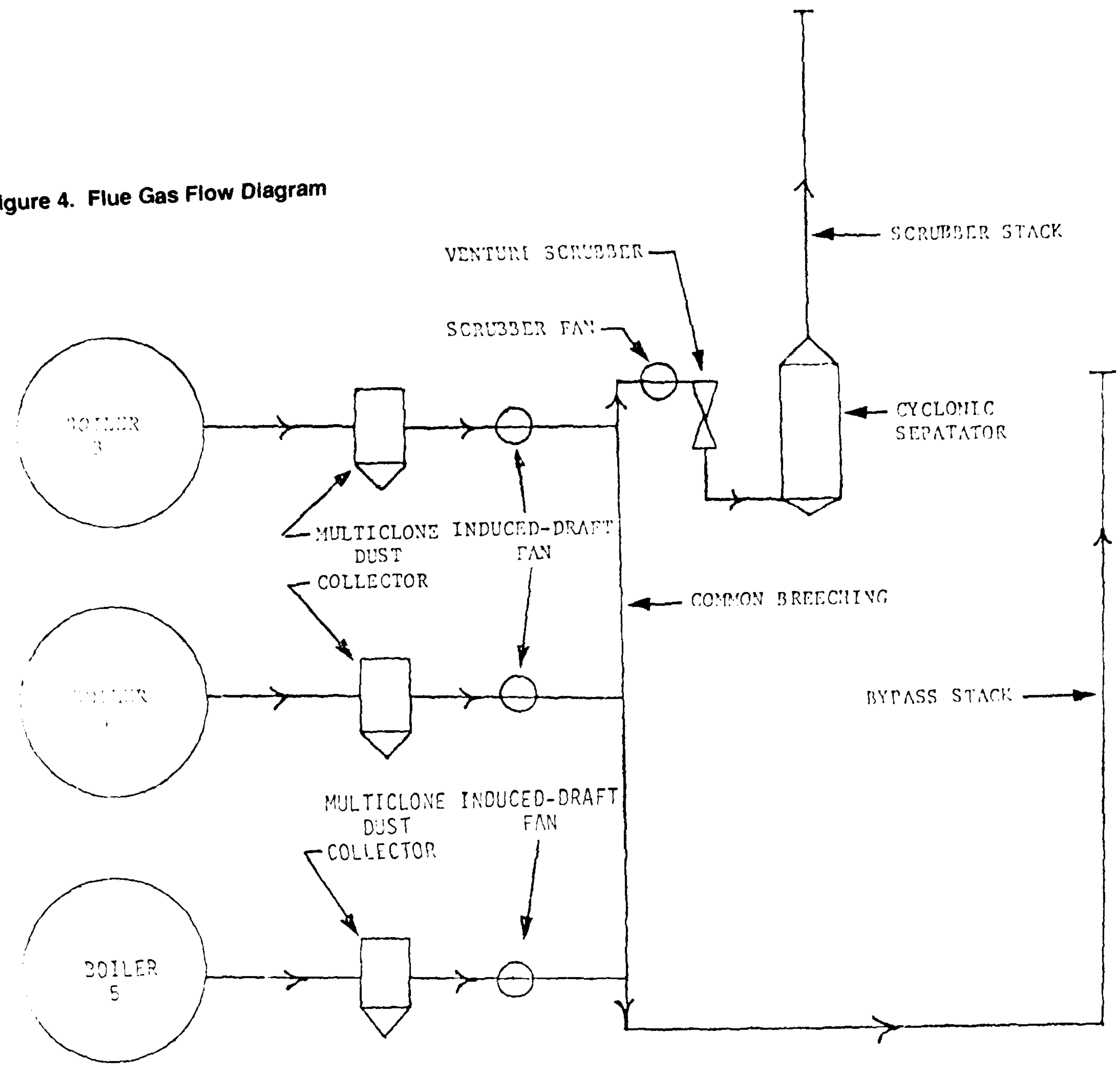


Figure 4. Flue Gas Flow Diagram



$$Pt = \frac{C \times a \times h}{76.5 \times Q^{0.75} \times N^{0.25}}$$

Where:

Pt = Pounds of particulate matter emitted per million Btu heat input (lb/mmBtu).

C = Maximum ground level concentration with respect to distance from the point source at the "critical" wind speed for level terrain (50 micrograms per cubic meter-provided in standard).

Q = Total source maximum operating capacity rating in million Btu per hour (mmBtu/hr) heat input (50.0 mmBtu/hr - boiler 3, 82.4 mmBtu/hr - boiler 5: determined from plant operation).

N = Number of stacks (1) in fuel burning operation

a = Plume rise factor (0.67 used for Q less than or equal to 1,000 mmBtu/hr heat input).

h = Stack height in feet (70 ft).

The limits on particulate emissions determined by the above equation and values of the variables applicable to this facility are 1.6 lb/mmBtu for boiler 3 and 1.1 lb/mmBtu for boiler 5. However, particulate emissions from facilities used for indirect heating purposes shall in no case exceed the following emission limitations: (1) 0.8 lb/mmBtu heat input for facilities existing and in operation on or before 8 June 1972 or (2) 0.6 lb/mmBtu heat input for any facility which has 250 mmBtu/hr heat input or less and which began operation after 8 June 1972. Item (1) applies to boiler 3 and item (2) applies to boiler 5. State regulations are presented in Appendix B.

D. Sampling Methods and Procedures

Boiler 3 was tested through scrubber A. Boiler 5 was tested through both scrubber A and the bypass stack. Emission testing was conducted only on scrubber A since scrubber B was not operational at the time of the survey. Boiler 4 was not tested due to a stoker malfunction. Coordination was made with plant personnel to operate each boiler at 95% capacity or greater during testing. One of the three runs which comprised a complete test included a soot blow; this is indicated on the field data sheets. Boiler operating logs for the test periods are provided in Appendix C. These logs indicate hourly steam output and coal usage. Laboratory results for the coal analysis are provided in Appendix D. Each coal sample represents an integrated sample collected over a particular one hour test run as noted on the analysis sheet.

325 IAC 3 requires that all emissions tests be conducted in accordance with the procedures and analysis methods specified in 40 CFR 60, Appendix A, Methods 1-5. Therefore, test methods, equipment, sample train preparations, sampling and recovery, calibration requirements and quality assurance were done in accordance with the methods and procedures outlined in 40 CFR 60, Appendix A.

Sampling ports were in place on the scrubber stack and located 1.4 stack diameters upstream from the stack exit and 5.6 stack diameters downstream from any disturbance (cyclonic separator). Based on a 5 ft inside stack diameter, port location and type of sample (particulate), a total of twenty traverse points were determined for emission evaluation. Sampling ports were also in place on the bypass stack and were located 2 stack diameters upstream from the stack exit and 7 stack diameters downstream from the nearest disturbance (common breeching inlet). Based on a 5.5 ft inside stack diameter, port location and type of sample (particulate), a total of twelve traverse points were determined for emission evaluation. The sampling time for each sampling run was 60 minutes; therefore, the sampling time per traverse point in the scrubber stack was 3 minutes and 5 minutes per point in the bypass stack. Illustrations showing port locations and sampling points are provided in Appendixes E, F and G.

Prior to every sample run on each stack, a preliminary velocity pressure traverse was accomplished and cyclonic flow was determined. For acceptable flow conditions to exist in a stack, the average of the absolute value of the flow angle taken at each traverse point must be less than or equal to 20 degrees. The flow angle in the bypass stack averaged 11 degrees which indicated an acceptable flow condition. Straightening vanes were installed directly above the cyclonic separator in scrubber A to prevent cyclonic flow out of the separator into the stack. The resultant flow angle in the scrubber stack averaged 9 degrees.

During each sample run, a flue gas sample for orsat analysis (measures oxygen, and carbon dioxide for stack gas molecular weight determination and emissions correction) was taken. Orsat sampling and analysis equipment are shown in Figures 5 and 6. Flue gas moisture content, also needed for determination of gas molecular weight, was obtained during particulate sampling.

Particulate samples were collected using the sampling train shown in Figure 7. The train consisted of a button-hook probe nozzle, heated inconel probe, heated glass filter, impingers and pumping and metering device. The nozzle was sized prior to each sample run so that the gas stream could be sampled isokinetically; in other words, the velocity at the nozzle tip was the same as the stack gas velocity at each point sampled. Flue gas velocity pressure was measured at the nozzle tip using a Type-S pitot tube connected to a ten-inch inclined-verticle manometer. Type K thermocouples were used to measure flue gas as well as sampling train temperatures. The probe was heated to minimize moisture condensation. The heated filter was used to collect particulate materials. The impinger train (first, third and fourth impingers:modified Greenburg-Smith type, second impinger: standard Greenburg-Smith design) was used as a condenser to collect stack gas moisture. The pumping and metering system was used to control and monitor the sample gas flow rate.

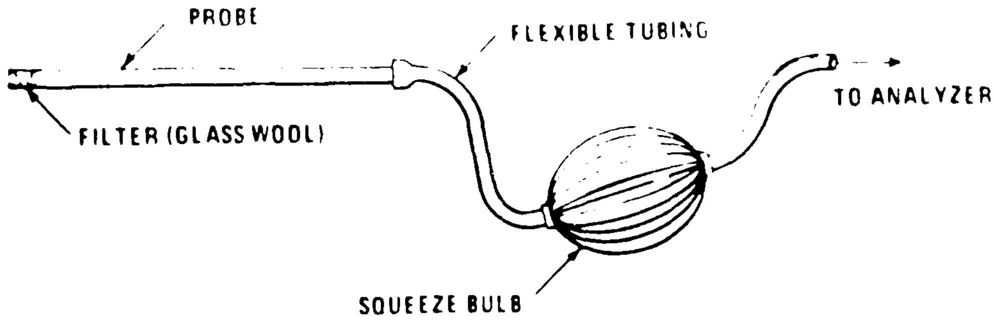


Figure 5. ORSAT Sampling Train

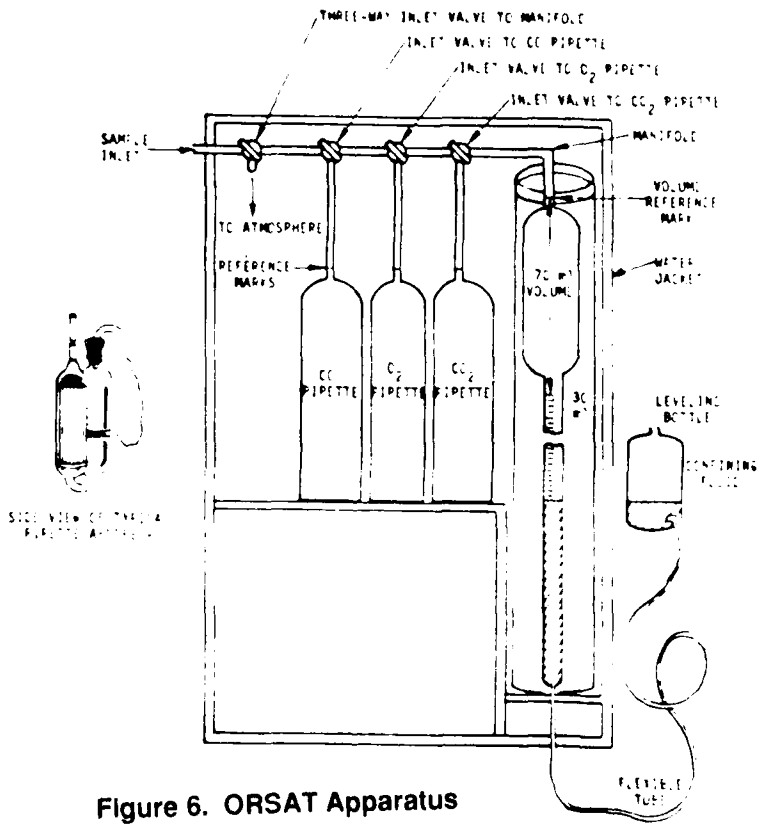


Figure 6. ORSAT Apparatus

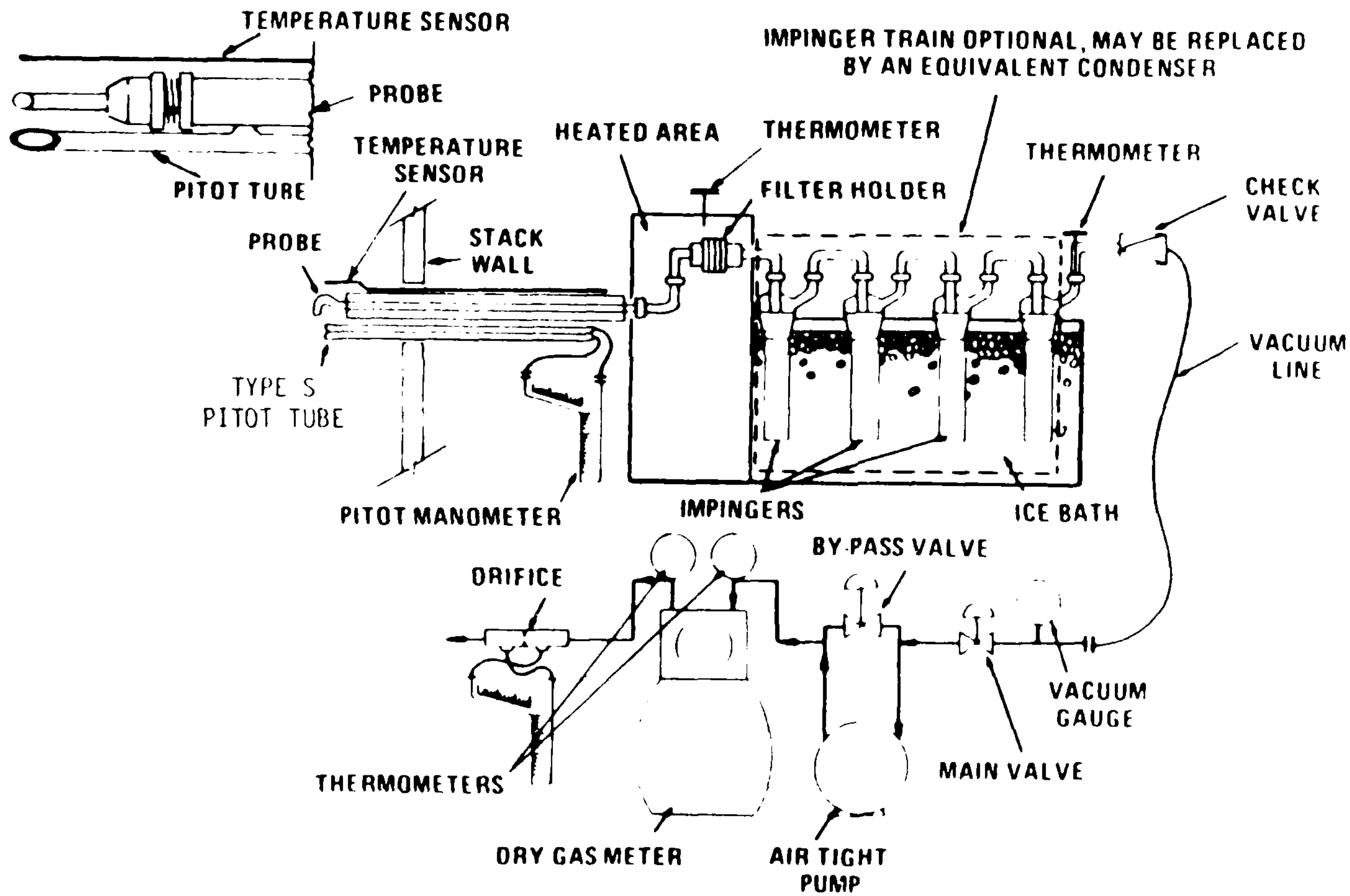


Figure 7. Particulate Sampling Train

Emission calculations were done using "Source Test Calculation and Check Programs for Hewlett-Packard 41 Calculators" (EPA-340/1-85-018) developed by the EPA's Office of Air Quality Planning and Standards, Research Triangle Park NC. This is our standard method for calculating emissions data. Calculations from the EPA programs are found in Appendix H. Calibration data is presented in Appendix I.

Method 9 determinations for opacity during this project was not accomplished since neither EPA Region V nor State observers were present.Region V had been notified in advance that a requirement existed for qualified observers since no one on our team was presently qualified to perform opacity determinations. Reply was that observers would be on hand if possible, but the Method 5 evaluations were of more importance.

III. CONCLUSIONS

The following table provides operating parameters for boilers 3 and 5 during testing and the resultant particulate emission rates determined from these tests. Results indicate that boiler 3 emissions through scrubber A were well below the emission standard of 0.8 lb/mmBtu with an emission rate of 0.35 lb/mmBtu. Boiler 5 emissions through scrubber A were well below the emission standard of 0.60 lb/mmBtu with a particulate emission rate of 0.09 lb/mmBtu. However, boiler 5 emissions through the bypass stack were above the 0.60 lb/mmBtu standard with a rate of 0.98 lb/mmBtu.

In our previous survey during November 1987, we noted that boiler 3 didn't meet the emission standard through scrubber B which was surprising since it met the standard through the bypass stack. If anything, the particulate emissions should have been less through the scrubber. At the time, we believed that two factors other than boiler operation may have contributed to the results: (1) a very low percentage of carbon dioxide (CO_2) was found in the exhaust gas from scrubber B (3%) as opposed to what was seen in the bypass stack exhaust (10%), and (2) material collected on the filter may have contained soda ash carry-over from the scrubber. It was thought that the low CO_2 value was caused by either the scrubber liquid absorbing the CO_2 or outside air being drawn into the system prior to the scrubber and diluting the exhaust gases.

To try and eliminate these two possible causes, we intended to evaluate gas stream CO_2 and Na content prior to and after scrubber B. The proposed evaluation of scrubber B during this survey was not possible since it was not operational, however, scrubber A was evaluated. Results indicated that there was little change in CO_2 percentage between the scrubber inlet and outlet with the inlet values averaging 8.9% and the outlet values averaging 9.4%. Evaluation of two of the Method 5 one-hour runs for boiler 5 through the bypass stack and scrubber indicate that the contribution of sodium to total filter mass averaged 0.085% and 0.74% respectively - an insignificant contribution.

At this time, boilers 3 and 4 meet applicable emission standards when exhausted through the bypass stack. Boilers 3 and 5 meet emission standards when exhausted through scrubber A and boiler 4 meets the standard when exhausted through scrubber B.

IV. RECOMMENDATIONS

It is our recommendation that boiler 5 be retested; however, all aspects of the system (boiler, particular control devices, etc.) should be evaluated for proper operation prior to testing.

It is our recommendation that EPA, Region V, should make the final determination as to whether it is necessary at this point to eva'uate boiler 4 through scrubber A and conduct a retest of boiler 3 through scrubber B.

Table 1

STACK EMISSION TESTING RESULTS

DATE	TIME (MILITARY)	BOILER NO.	STACK NO.	RUN NO.	BOILER OPERATING CAPACITY (%)	SOOT BLOW	COAL HEAT VALUE (Btu/lb)	COAL USE (lb/hr)	HEAT INPUT (mmBtu/hr)	*PM EMISSIONS (lb/hr)	PM EMISSIONS (lb/mmBtu)
8 MAR 88	1100	5	**BP	1	95.0		11906	6544	77.9	57.1	0.73
9 MAR 88	1330	5	BP	2	96.0		11799	6710	79.2	74.6	0.94
9 MAR 88	1535	5	BP	3	96.0	X	11883	6933	82.4	105.3	1.28
					AVG = 96.0					AVG = 79.0	AVG = 0.98
10 MAR 88	1000	5	***SC	1	98.0		11896	7111	84.6	9.9	0.11
11 MAR 88	0750	5	SC	2	99.0		11743	7778	91.3	7.5	0.08
11 MAR 88	0915	5	SC	3	101.0	X	11888	7278	86.5	7.0	0.08
					AVG = 99.0					AVG = 8.1	AVG = 0.09
13 MAR 88	0930	3	SC	1	95.0	X	11785	4222	49.8	19.6	0.39
13 MAR 88	1205	3	SC	2	95.0		11749	4222	49.6	9.2	0.19
13 MAR 88	1443	3	SC	3	95.0		11905	4197	50.0	23.8	0.48
					AVG = 95.0					AVG = 17.5	AVG = 0.35

* PARTICULATE EMISSIONS
** BYPASS STACK
*** SCRUBBER STACK

REFERENCES

1. "Standards of Performance for New Stationary Sources", Title 40, Part 60, Code of Federal Regulations, July 1, 1987.

2. Quality Assurance Handbook for Air Pollution Measurement Systems - Volume III, Stationary Source Specific Methods, U.S. Environmental Protection Agency, EPA-600/4-77-027-b, Research Triangle Park, North Carolina, December 1984.

3. Source Test Calculation and Check Programs for Hewlett-Packard 41 Calculators. U.S. Environmental Protection Agency, EPA-340/1-85-018, Research Triangle Park, North Carolina, May 1987.

APPENDIX A
Personnel Information

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1. USAFOEHL Test Team

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Capt Mary Daly, Consultant, Air Quality Engineer

1Lt Mark Dibben, Chemist

SGT Robert Davis, Environmental Engineering Technician

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APPENDIX B
State Regulations

(B) When the owner or operator elects under Section 8(a) *[325 IAC 3-2-8(1)]* of this Rule to measure carbon dioxide in the flue gases, the measurement of the pollutant concentration and the carbon dioxide concentration shall each be on a consistent basis (wet or dry) and the following conversion procedure used;

$$E = CF_c \quad \frac{(100)}{(\%\ CO_2)}$$

(C) When the owner or operator elects under Section 8(a) *[325 IAC 3-1-8(1)]* of this Rule to measure sulfur dioxide or nitrogen oxides in the flue gases, the measurement of the pollutant concentration and the sulfur dioxide and/or the nitrogen oxides concentration(s) shall each be on a wet basis and the following conversion procedure used except where wet scrubbers are employed or where moisture is otherwise added to the stack gases;

$$E = C_{ws}F_w \quad \frac{(20.9)}{(20.9\,(1\text{-}B_{wa})\text{-}\%O_{2ws})}$$

(D) When the owner or operator elects under Section 8(a) *[325 IAC 3-1-8(1)]* of this Rule to measure sulfur dioxide or nitrogen oxides in the flue gases, the measurement of the pollutant concentration and the sulfur dioxide and/or the nitrogen oxides concentrations(s) shall each be on a wet basis and the following conversion procedure used where wet scrubbers or moisture is otherwise present in the stack gases provided water vapor content of the stack gas is measured at least once every fifteen minutes at the same point as the pollutant and oxygen measurements are made;

$$E = C_{ws}F \quad \frac{(20.9)}{(20.9\,(1\text{-}B_{ws}) - \%O_{2ws})}$$

(F) The values used in the equations under this Section are derived as follows:
C_{ws} = pollutant concentration at stack conditions, g/wscm (grams/wet standard cubic meter), lb/wscm (pounds/wet standard cubic meter), determined by multiplying the average concentration (ppm) for each one hour period by 4.15 X 10^{-5} Mg/wscm per ppm (2.59 X 10^{-9} M lb/wscm per ppm) where M is pollutant molecular weight, g/g-mole (lb/lb mole).
M = 64.07 for sulfur dioxide and 46.01 for nitrogen oxides.
C = as above but measured in terms of pounds/dry standard cubic meter (lb/dscm) or grams/dry standard cubic meter (g/dscm).
F, F_c = a factor representing a ratio of the volume of dry flue gases generated to the calorific value of the fuel combusted (F), and a factor representing a ratio of the volume of carbon dioxide generated to the calorific value of the fuel combusted (F_c), respectively. Values of F and F_c are given in Section 60.45(f) of 40 CFR Part 60, as applicable.
F_w = a factor representing a ratio of the volume of wet flue gases generated to the calorific value of the fuel combusted. Values of F_w are:

(i) For anthracite coal as classified according to A.S.T.M. D388-66, F_w = 1.188 wscm/million calories (10580) wscf/million BTU).

(ii) For sub-bituminous and bituminous coal as classified according to A.S.T.M. D388-66, F_w = 1.200 wscm/million calories (10680 wscf BTU).

(iii) For liquid fossil fuels including crude, residual, and distillate oils, F_w = 1.164 wscm/million calories (10360 wscf/million BTU).

(iv) For gaseous fossil fuels: for natural gas, F_w = 1.196 wscm/million calories (10650 wscf/milion BTU; for propane, F_w = 1.150 wscm/million calories (10240 wscf/million Btu); for butane F_w = 1.172 wscm/million calories (10430 wscf/million BTU).
B_{wa} = proportion by volume of water vapor in the ambient air.
B_{ws} = proportion by volume of water vapor in the stack gas.
$\%O_2$, $\%CO_2$ = Oxygen or carbon dioxide volume (expressed as percent) determined with equipment specified under Section 8 *[325 IAC 3-1-8]* of this Rule.
E = pollutant emission, lb/million BTU.

(2) For sulfuric acid plants the owner or operator shall:

(A) Establish a conversion factor three times daily according to the procedures of Section 60.84(b) of 40 CFR Part 60;

(B) Multiply the conversion factor by the average sulfur dioxide concentration in the flue gases to obtain average sulfur dioxide emissions in lb/ton; and

(C) Report the average sulfur dioxide emission for each 3-hour period in excess of the emission standard set forth in 325 IAC 7-1 (formerly known as APC-13), in the quarterly summary.

(3) For nitric acid plants the owner or operator shall:

(A) Establish a conversion factor according to the procedurders of Section 60.73(b) of 40 CFR Part 60;

(B) Multiply the conversion factor by the average nitrogen oxides concentration in the flue gases to obtain nitrogen oxides emissions in lb/ton;

(C) Report the average nitrogen oxides for each averaging period in excess of the emission standard set forth in 325 IAC 10-1 (formerly known as APC-17), in the quarterly summary.

(4) Alternate Data Reporting and Reduction Procedures.

(A) Alternate procedures for computing emission averages that do not require integration of data may be approved by the APCB if the owner or operator shows that his procedures are at least as accurate as those in this Rule *[325 IAC 3-1]*.

(B) Alternative methods of converting pollutant concentration measurements to units of the emission standard may be approved by the APCB if the owner or operator shows that his procedures are at least as accurate as those in this Rule *[325 IAC 3-1]*.

Rule 2. Source Sampling Procedures

Sec. 1. Applicability. this rule applies to any emissions testing performed in the State to determine compliance with applicable emission limits contained in this Title (Air Pollution Control Board Rules), or for any other purpose requiring review and approval by the APCB

Sec. 2. Adoption of Federal Test Procedures. Emissions tests subject to this Rule shall be conducted in accordance with the procedures and analysis methods specified in Title 40, Code of Federal Regulations Part 60, Appendix A and Part 61 Appendix B, as in effect on December 2, 1981. Such test methods, equipment, calibration requirements, and analysis must be strictly followed unless otherwise approved by the Board or the Technical Secretary. If any test method is revised as contained in the Code of Federal Regulations, this Rule is subject to change pursuant to IC 4-22-2.

Sec. 3. Requirements Prior to Conducting Tests. (a) When a test is to be performed by any person other than staff, a test protocol form shall be completed and received by the Board no later than 35 days prior to the intended test date. Such test protocol shall be on a form approved by the Board. Any special or unique information relative to the scheduled test shall be included with the form.

(b) After evaluating the completed test protocol form, the Board or the Technical Secretary.

(1) Inspect the test site.

(2) Require additional conditions, including, but not limited to the following:

(A) Reasonable modifications to the stack or duct to obtain acceptable test conditions.

(B) A pretest meeting to resolve an acceptable test protocol,

(C) Additional tests to allow for adverse conditions such as interferences, non-steady or cyclic processes.

(D) The keeping of process operating parameter records, operating logs or charts during the test,

(E) Conditions on control equipment operation to make it representative of future normal operation, or

(F) The recording of specified control equipment operating parameters during the test.

(c) If the Board or the Technical Secretary requires modifications to the test methods, analytical methods, operational parameters or other matters included in the test protocol, or if a pretest meeting is required, the source operator and the testing firm shall be notified by letter or telephone at least 25 days prior to the proposed test date. The source operator will receive notice of the acceptability of the test protocol from the Board or the Technical Secretary within 10 days of its receipt. If the source operator or test firm desires to change any previously submitted procedures or conditions, the Board must be notified of such change at least 25 days prior tot he intended test date, and such changes cannot be made unless approved by the Board or the Technical Secretary prior to the test. Changes in the test protocol that result from emergency conditions must be approved by an authorized on-site staff member.

(d) The Board or the Technical Secretary reserves the right to conduct any portion of the reference method tests. In such case, a 25-day notice of proper test procedures will be given to the company and their testing representative.

(e) The source operator must notify the Board of the actual test date at least two weeks prior to the date.

Sec. 4. Performance of Test. (a) Staff may observe the field test procedures and plant operation during the test.

(b) All tests shall be conducted while the source is operating at between 95% to 100% of its maximum operating capacity, or under other capacities or conditions specified and approved by the Board or the Technical Secretary. For the purpose of this rule, maximum operating capacity means the maximum design capacity of the source or other maximum operating capacities agreed to by the source and the Board or the Technical Secretary.

(c) Sources subject to Article 12 of this Title (New Source Performance Standards) shall be tested under conditions as specified in the applicable Rule.

(d) Calibration results of the various sampling components must be available for examination at the test site. The information must include dates, methods used, data and results. All components requiring calibration must be calibrated within 60 days prior to the actual test date. Post test calibrations must be performed on the components within 45 days after the actual test date or before the equipments' next field use whichever comes first. Components requiring calibration are listed in the Federal test methods specified in Section 2 above. Calibration need not be done between tests when several facilities at one location are tested in series, as long as the units are calibrated prior to the first test and after the last test in the series which is conducted at that site.

Sec. 5. Test Results and Reports. (a) All tests shall be reported to the Board or the Technical Secretary in the form of a test report containing the following information (which can be kept confidential upon request):

(1) Certification by team leader and reviewer.

(2) Introduction, containing.

(A) Date and type of tests,

(B) Type of process and control equipment,

(C) Plant name and location,

(D) Purpose of test, and

(E) Test participants and titles.

(3) Results summary, containing:

(A) Tabulated data and results of each test run, process weight rate or heat input rate, the stack gas flow rate, the measured emissions given in units consistent with the applicable emission limits, and the visible emissions or average opacity readings, and

(B) Allowable emission rate.

(4) Process information, including.

(A) Description of process and control device,

(B) Process flow diagram,

(C) Maximum design capacities,

(D) Fuel analysis and heat value for heat input rate determination,

(E) Process and control equipment operating conditions during tests,

(F) Discussion of variations from normal plant operations, and

(G) Stack height, exit diameter, volumetric flow rate (acfm), exit temperature, and exit velocity.

(5) Sampling information, including

(A) Description of sampling methods used,

(B) Brief discussion of the analytical procedures with justification for any variance from standard procedures,

(C) Specification of the number of sampling points, time per point, and total sampling time per run,

(D) Cross sectional diagram showing sampling points, diagram showing stack dimensions, sampling location and distance from the nearest flow disturbance upstream and downstream of the sampling points, and

(E) Sampling train diagram.

(6) Appendix, containing:

(A) Sampling and analytical procedures

(B) Results and calculations — One complete calculation using actual data for each type of test performed must be shown. Results must be stated to units consistent with the applicable emission limitation

(C) Raw production data signed by plant official

(D) Photocopies of all actual field data or original raw field data.

(E) Laboratory report with chain of custody shown.

(F) Copies of all calibration data,

(G) Applicable regulations showing emission limitation, and

(H) Copies of visible emissions observations or opacity monitor readings (for TSP tests).

(b) Unless previously agreed to in writing by the Board or the Technical Secretary, all test reports must be received by the Board within forty-five (45) days of the completion of the testing.

Sec. 6. Special Requirements for Testing Certain Pollutants. (a) Particulate matter tests shall be conducted in accordance with the following procedures:

(1) Method 5, Title 40 Code of Federal Regulations, Part 60, Appendix A, as in effect on December 2, 1981, or other procedures approved by the Board or the Technical Secretary shall be used.

(2) Visible emissions (VE) evaluation shall be performed in conjunction with a particulate emissions test by a qualified observer in accordance with the procedures contained in 325 IAC 5-1-4. VE readings shall be continuously recorded for at least 30 minutes per hour of sampling time for each sampling repetition. A variance from this requirement may be granted by the on-site staff person for one repetition only and provided that adverse conditions exist which would invalidate the VE readings. Sources equipped with continuous opacity monitors may submit the monitor's instantaneous or six-minute integrated readings during the sampling period, in lieu of performing VE observations; provided.

(A) The monitoring system meets the Performance Specifications Tests 1 as specified in 40 CFR 60, Appendix B as in effect on December 2, 1981, and

(B) The monitor readings submitted with the test include a zero and span calibration check at the start and end of each test.

(3) At least three (3) repetitions of the test must be performed under identical source operating conditions unless otherwise allowed by the Board or the Technical Secretary.

(4) During each of the repetitions, each sampling point shall be sampled for a minimum of two (2) minutes.

(5) The total test time per repetition shall be no less than sixty (60) minutes.

(6) The total sample volume per repetition shall be no less than thirty (30) dry standard cubic feet (dscf).

(7) The total particulate weight collected from the sampling nozzle, probe, cyclone (if used), filter holder (front half), filter and connecting glassware shall be reported. Particulate analysis of the impinger catch is not required unless specified by staff.

(b) Sulfur dioxide (SO_2) tests shall be conducted in accordance with the following procedures:

(1) Method 6 or Method 8, Title 40 Code of Federal Regulations, Part 60, Appendix A, as in effect on December 2, 1981, or other procedures approved by the Board or the Technical Secretary shall be used.

(2) At least three (3) repetitions of two (2) samples, each of Method 6 or three (3) repretitions of Method 8 performed under identical source operting conditions, shall constitute a test.

(3) During each of the repetitions for Method 8, each sampling point shall be sampled for a minimum of two (2) minutes.

(4) The total test time per repetition shall be as follows:

(A) Method 6 — a minimum of 20 minutes per run with a 30 minute interval between each run, or

(B) Method 8 — a minimum of 60 minutes per run.

(5) The total sample volume per repetition under Method 8 shall be no less than 40 dry standard cubic feet (dscf).

(c) Nitrogen oxide tests shall be conducted in accordance with the following procedures:

(1) Method 7, Title 40, Code of Federal Regulations, Part 60, Appendix A as in effect on December 2, 1981, or other procedures approved by the Board or the Technical Secretary shall be used.

(2) At least three (3) repetitions of four (4) samples each shall constitute a test.

(d) Volatile Organic Compounds (VOC) emissions tests shall be conducted in accordance with the following procedures:

(1) Method 25, Title 40 Code of the Federal Regulations, Part 60, Appendix A as in effect on December 2, 1981, or other procedures approved by the Board or duly authorized staff member shall be used for the total non-methane organic (TNMO) emissions.

(2) At least three (3) duplicate samples must be collected and analyzed.

(3) The total test time per repetition shall be a minimum of sixty (60) minutes.

Sec. 7. Invalid Tests. Any tests not meeting the requirements of this Rule may be treated by staff and the Board as invalid for any and all purposes.

Sec. 8. Board Resolves Disputes. A source operator or testing firm may appeal to the Board any decision made by staff under the discretionary terms of this Rule. Any person desiring to make such an appeal shall notify staff of the matters to be appealed, and, if agreement cannot be reached, the matter shall be presented to the Board for a final determination. The Board may appoint one of its members to hear the matter and make recommendations for a final decision by the full Board.

ARTICLE 4. BURNING REGULATIONS

Rule 1. Open Burning

Sec. 1. Applicability—This Rule *[325 IAC 4-1-]* establishes standards for the open burining of material which would result in emissions of regulated pollutants and applies everywhere in the State. However, this Rule *[325 IAC 4-1]* shall not apply in areas where acts permitted by Section 3 *[325 IAC 4-1-3]* or authorized by variance pursuant to Section 4 *[325 IAC 4-1-4]* are prohibited by other State and/or local laws, regulations, or ordinances such as IC 13-7-4-1(g).

Sec. 2. Prohibition—No persons shall open burn any material except as provided in Section 3 *[325 IAC 4-1-3]* or Section 4 *[325 IAC 4-1-4]*.

Sec. 3. Exemptions. (a) The following types of fires are permitted:

(1) Fires celebrating Twelfth Night Ceremonies.

(2) Fires celebrating school pep rallies.

(3) Fires celebrating scouting activities.

(4) Camp fires.

(5) Residential burning—where residence contains four or fewer units. Burning shall be in a noncombustible container with enclosed sides a bottom, and a mesh covering with openings no larger than 1/4" square. Burning is prohibited in apartment complexes and mobile home parks.

(6) Farm burning—wood products derived from farming operations. Clearing operations (Section 4(a)(4) *[325 IAC 4-1-4(a)(4)]* are not considered farm burning.

(7) Waste oil burning—where the waste oil has been collected in a properly constructed and located pit as prescribed in 310 IAC 7-1-37(A) (Rule 37A of the Division of Oil and Gas, Department of Natural Rersouces) at an oil well. Each oil pit may be burned once every two (2) months and all the oil must be completely burned within thirty (30) minutes after ignition.

(b) All exemptions shall be subject to the following:

(1) Only wood products shall be burned unless otherwise stated above.

(2) Fires shall be attended at all times until completely extinguished.

(3) If fires create an air pollution problem, a nuisance, or a fire hazard, they shall be extinguished.

(4) All residential, farm operation, and waste oil burning shall occur during daylight hours during which the fires may be replenished, but only in such a manner that nearly all of the burning material is consumed by sunset.

(5) No burning shall be conducted during unfavorable meteorological conditions such as temperature inversions, high winds, air stagnation, etc.

Sec. 4. Variances. (a) Burning with prior approval of the board or its designated agent may be authorized for the following:

(1) Emergency burning of petroleum products.

(2) Burning of refuse consisting of material resulting from a natural disaster.

(3) Burning for the purpose of fire training.

(4) Burning of natural growth derived from a clearing operation, i.e., removal of natural growth for change in use of the land.

(5) Burning of highly explosive or other dangerous materials.

(b) Burning not exempted by Section 3 *[325 IAC 4-1-3]* may be permitted with prior receipt of a variance application and approval of the Board. *(Air Pollution Control Board)*

Sec. 5. Liability—Any person who allows the accumulation or existence of combustible material which constitutes or contributes to a fire causing air pollution shall not be excused from responsibility therefore on the basis that said fire was accidental or an act of God.

Rule 2. Incinerator

Sec. 1. Applicability—This Rule *[325 IAC 4-2]* establishes standards for the use of incinerators which emit regulated pollutants. This rule *[325 IAC 4-2]* does not apply to incinerators in residential units consisting of four or fewer families. All other incinerators are subject to this rule. *[325 IAC 4-2]*.

Sec. 2. Stationary Incinerators—All stationary incinerators shall:

(1) Consist of primary and secondary chambers or the equivalent.

(2) Be equipped with a primary burner unless burning wood products.

(3) Comply with 325 IAC 5-1 (formerly known as APC 3) and 325 IAC Article 2 (formerly known as APC 19).

(4) Be maintained properly as specified by the manufacturer and approved by the Board or its designated agent.

(5) Be operated according to the manufacturer's recommendations and only burn waste approved by the Board or its designated asgent.

(6) Comply with other state and/or local regulations or ordinances regarding installation and operation.

(7) Be operated so emissions of hazardous material including, but not limited to, viable pathogenic bacteria, dangerous chemicals or gases, or noxious odors are prevented

(8) Not emit particulate matter in excess of the following:

(A) Incinerators with a maximum refuse-burning capacity of 200 or more pounds per hour: 0.3 pounds of particulate matter per 1,000 pounds of dry exhaust gas at standard conditions as corrected to 50% excess air.

(B) All other incinerators: 0.5 pounds of particulate matter per 1,000 pounds of dry exhaust gas at standard conditions corrected to 50% excess air.

(9) Not create an air pollution problem, a nuisance or a fire hazard. If any of the above result, the burning shall be terminated immediately

Sec. 3. Portable Incinerators—All portable incinerators shall be subject to the following conditions:

(1) Approval of the Board or its designated agent must be obtained prior to operation at a new project site.

(2) Only wood products shall be burned.

(3) Merchantable material shall be salvaged where practicable.

(4) The local health department shall be notified prior to any burning.

(5) All burning shall be conducted under favorable meteorological conditions.

(6) Burning shall occur during daylight hours and all material shall be consumed by sunset.

(7) If burning creates an air pollution problem, a nuisance or a fire hazard, the burning shall be terminated immediately.

(8) The incinerator shall be maintained and operated according to the manufacturer's recommendations and in a manner approved by the Board or its designated agent.

(9) The installation and operation of such an apparatus shall comply with all other state and/or local regulations or ordinances.

(10) A portable incinerator shall comply with both 325 IAC 5-1 (formerly known as APC 3) and 325 IAC, Article 2 (formerly known as APC 19).

ARTICLE 5. OPACITY REGULATIONS

Rule 1. Opacity Limitations

Sec. 1. Applicability. (a) This rule *[325 IAC 5-1]* shall apply to all visible emissions (not including condensed water vapor) emitted by or from any facility or source except those sources or facilities for which specific visible emission limitations are established by 325 IAC, Article 11, 325 IAC, Article 12, or 325 IAC, Article 6.

(1) The requirements of Section 2(a)(1) *[325 IAC 5-1-2(a)]* shall apply to sources or facilities located in attainment areas for particulate matter, designated in 325 IAC 1.1-3 (formerly known as APC 22).

(2) The requirements of Section 2(a)(2) *[325 IAC 5-1-2(a)(2)]* shall apply to sources or facilities located in nonattainment areas for particulate matter as designated in 325 IAC 1.1-3 (formerly known as APC 22).

(b) Sources or facilities located in areas designated as unclassifiable or attainment areas in 325 IAC 1.1-3 (formerly Regulation APC 22) which became subject to more stringent limitations as a result of said area being redesignated as a nonattainment area by the Board, shall comply with such limitations as expeditiously as practable, but no later than December 31, 1982. No later than 60 days after the promulgation of the nonattainment designation in 325 IAC 1.1-3, all sources or facilities subjected to more stringent visible emission limitations by their redesignation shall submit to the Board for approval a schedule for attaining compliance with this Rule *[325 IAC 5-1]*.

Sec. 2. Emission Limitations. (a) Visible emissions from any source or facility shall not exceed any of the following limitations. Unless otherwise stated, all visible emissions shall be observed in accordance with the procedures set forth in Section 4 *[325 IAC 5-1-4]* of this rule:

(1) Sources or facilities of visible emissions located in attainment areas for particulate matter shall meet the following limitations:

(A) Visible emissions shall not exceed, an average of 40% opacity in 24 consecutive readings.

(B) Visible emissions shall not exceed 60% opacity for more than a cumulative total of 15 minutes (60 readings) in a 6-hour period.

(2) Sources or facilities of visible emissions located in nonattainment areas shall meet the following limitations:

(A) Visible emissions shall not exceed, an average of 30% opacity in 24 readings.

(B) Visible emisions shall not exceed 60% opacity for more than a cumulatie total of 15 minutes (60 readings) in a 6-hour period.

(3) Sources and facilities of visible emissions located in both attainment or nonattainment areas, for which an alternate visible emission limitation has been established pursuant to Secton 5(b) *[325 IAC 5-1-5(b)]* herein, shall comply with said limitations in lieu of the limitations set forth in subsection 2(a)(1) and 2(a)(2) *[subsections (a)(1) and (a)(2) of this section]* preceding.

Sec. 3. Temporary Exemptions. (a) Boiler Startup and Shutdown—When building a new fire in a boiler, or shutting down a boiler, visible emissions may exceed the applicable opacity limit established in Section 2(a) *[325 IAC 5-1-2(a)]*; however, visible emissions shall not exceed an average of 60% opacity and emissions in excess of the applicable opacity limit shall not continue for more than 10 continuous minutes on one occasion in any 24-hour period.

(b) Cleaning Boilers—When removing ashes from the fuel bed or furnace in a boiler or blowing tubes, visible emissions may exceed the applicable opacity limit established in Section 2(a) *[325 IAC 5-1-2(a)]*; however, visible emissions shall not exceed 60% opacity and visible emissions in excess of the applicable opacity limit shall not continue for more than five continuous minutes on one occasion in any 60-minute period. Such emissions shall not be permitted on more than three occasions in any 12-hour period.

(c) Facilities not temporarily exempted by Subsections (a) and (b) above may be granted special temporary exemptions by the Board of the same duration and type authorized therein provided that the facility proves to the satisfaction of the Board that said exemptions are needed and that during periods of startup and shutdown, owners and operators shall, to the extent practicable, maintain and operate any affected facility including air pollution control equipment in a manner consistent with good air pollution control practice for minimizing emissions. Determination of whether acceptable operating and maintenance procedures are being used will be based on information available to the Board, which may include, but is not limited to, monitoring results, opacity observations, review of operating and maintenance procedures and inspection of the source.

(d) Sources or facilities not exempted through subsections (a), (b), or (c) above may also be granted special exemptions by the Board, provided that the source or facility owner or operator proves to the satisfaction of the Board that said exemption is justifiable. Said exemption(s) may be of longer duration and may apply to other types of facilities not provided for in subsections (a) and (b) above.

Sec. 4. Procedure to Determine Compliance. (a) Determination of visible emissions from sources or facilities to which this Rule *[325 IAC 5-1]* applies may be made in accordance with subsections (1) and (2) below.

(1) Determination of visible emissions by means of a qualified observer shall be made according to the following provisions (A) through (H).

(A) Position—The qualified observer shall stand at a distance sufficient to provide a clear view of the emissions with the sun, if visible, oriented in the 140° sector to his back. Consistent with maintaining the above requirement, the observer shall, as much as possible, make his observations from the position such that his line of vision is approximately perpendicular to the direction of the visible emissions (plume where applicable), and when observing opacity of emissions from rectangular outlets (e.g., monitors open baghouses, noncircular stacks), approximately perpendicular to the longer axis of the outlet. The observer's line of sight should not include more than one plume at a time when multiple stacks are involved, and in any case the observer should make his observations with his line of sight perpendicular to the longer axis of such a set of multiple stacks (e.g., stub stacks on baghouses).

(B) Field Records—The observer shall record the name of the plant, emission location, type of facility, observer's name and affiliation, and the date on a field data sheet. Time, estimated distance to the emission location, approximate wind direction, estimated wind speed, description of the sky conditions (presence and color of clouds), and visible emissions (plume where applicable) background are recorded on a field data sheet at the time opacity readings are initiated and completed.

(C) Observations—Opacity observations shall be made at the point of greatest opacity in that portion of the visible emissions, (plume where applicable) where condensed water vapor is not present. The observer shall not look continuously at the visible emissions, (plume where applicable) but instead shall observe the visible emissions, (plume where applicable) mometarily at 15-second intervals.

(D) Recording Observations—Opacity observations shall be recorded to the nearest 5% at 15-second intervals on an observational record sheet. A minimum of 24 observations shall be recorded. Each momentary observation shall be deemed to represent the average opacity of emissions for a 15-second period.

(E) Determination of Opacity As An Average of 24 Consecutive Observations—Opacity shall be determined as an average of 24 consecutive observations recorded at 15-second intervals. Divide the observations recorded on the record sheet into sets of 24 consecutive observations. A set is composed of any 24 consecutive observations. Sets need not be consecutive in time and in no case shall two sets overlap. For each set of 24 observations, calculate the average by summing the opacity of the 24 observations and dividing this sum by 24. Record the average opacity on a record sheet. For the purpose of determining an alternative visible emission limit in accordance with Section 5(b) *[325 IAC 5-5-5(b)]* following, an average of 24 consecutive readings or more may be used to calculate the alternative visible emissions limit.

(F) Determination of Opacity As A Cumulative Total of 15 Minutes—For emissions from intermittent sources, opacity shall be determined in accordance with subsections (1), (2), (3), and the first sentence of (4). Each momentary observation shall be deemed to represent the average opacity of emissions for a 15 second period. All readings greater than the specified limit in Section 2 *[325 IAC 5-1-2]* shall be accumulated as 15 second segments for comparison with the limit.

(G) Attached Steam Plumes—When condensed water vapor is present within the plume as it emerges from the emission outlet, opacity observations shall be made beyond the point in the plume at which condensed water vapor is no longer visible. The observer shall record the approximate distance from the emission outlet to the point in the plume at which the observations are made.

(H) Detached Steam Plumes—When water vapor in the plume condenses and becomes visible at a distinct distance from the emission outlet, the opacity of emissions should be evaluated at the emission outlet priror to the condensation of water vapor and the formation of the steam plume.

(2) Determination of compliance with visible emission limitations established in this Rule *[325 IAC 5-1]* may also be made in accordance with a source's or facility's continuous monitoring equipment, for any source or facility in compliance with the requirements of 325 IAC 3-1.

(b) If the compliance determination procedures set forth in subsection (1) and (2) preceding results in any conflict in visible emission readings, the determination made in accordance with subsection (2) above shall prevail for the purpose of compliance, provided that it can be shown that the continuous monitor has met the performance specifications as set forth in the U.S. EPA Federal Reference 40 CFR, Part 60, specifically Performance Specification 1.

Sec. 5. Special Considerations. (a) A violation of this Rule *[325 IAC 5-1]* shall constitute prima facie evidence of a violation of other applicable particulate emission control regulations. A violation of any such regulation can be refuted by a performance test conducted in accordance with paragraph (b), below. Such test shall refute the mass emission violation only if the source is shown to be in compliance with the allowable mass emission limit. An exceedance of the allowable opacity emission limit will not be treated as a violation if, during the test described in (b) below, the source demonstrates compliance with the allowable mass emission limit while simultaneously having visible emissions more than or equal to the reading at which the exceedance was originally observed.

(b) Establishment or Alternate Visible Emission Limits—The owner or operator of a source or facility which believes it can operate in compliance with the applicable mass emission limitation, but exceeds the limits specified in Section 2 *[325 IAC 5-1-2]* of this Rule, may submit a written petition to the Technical Secretary requesting that an alternate opacity limitation be established pursuant to the following provisions Additionally, if the Board has issued a Notice of Violation to an owner or operator of a source or facility for violation of the applicable opacity limitation, such owner or operator may, propose in Notice of Violation resolution, to disprove said violation by establishing an alternate opacity limit pursuant to the following provisions. This alternate limit shall be based upon a mass emission performance test conducted according to a method designated by the Board, and a visible emission test conducted simultaneously, according to Section 4 *[325 IC 5-1-4]* of this Rule. Where the Board determines there is no acceptable test method available, a request for an alternate visible emission limit shall be denied.

(1) The alternate emission limit shall be equal to that level of opacity at which the source or facility will be able, as indicated by the performance and opacity tests, to meet the opacity standard at all times during which the source or facility is meetng the mass emission limitation. However, the Board shall also reserve the right to determine the alternate visible emissions limit in the following manner:

(A) If a performance test of a source or facility demonstrates (i) that said source or facility is in compliance with the allowable mass emissions limit (as defined in 325 IAC 1.1.-1) at the time that the test is done, and: (ii) simultaneously, said source's or facility's test demonstrates that the allowable opacity emission limit is being exceeded, then, the enforceable opacity limitation shall be equal to that level of opacity at which the source or facility will be able as indicated by the performance and opacity tests to meet the opacity standard at all times during which the source or facility is meeting the mass emission limitation.

(B) If a performance test of a source or facility demonstrates (i) that said source of facility is in compliance with the allowable mass emission limit, and the test mass emission rate is within 10% of the allowable emissions limit for that source or facility, and; (ii) simultaneously, said source's or facility's test demonstrates that the opacity observed is below the allowable opacity emission limit, the enforceable opacity limitation shall be equal to that level of opacity at which the source or facility will be able as indicated by the performance and opacity tests, to meet the opacity standard at all times during which the source or facility is meeting the mass emission limitation.

(C) If a performance test of a source or facility demonstrates (i) that said source or facility is in compliance with the allowable mass emission limit, and the test mass emission rate is less than 90% of the allowable emissions limit and; (ii) simultaneously, said source's or facility's test demonstrates that the opacity observed is below the allowable opacity emission limit, the enforceable opacity limitation shall remain the existing allowable opacity emission limitation for that source or facility.

(2) Compliance with 325 IAC 6-2 (formerly known as APC 4R), 325 IAC 6-3 (formerly known as APC 5), 325 IAC 11-1 (formerly known as APC 6), and 325 IAC 6-1 (formerly known as APC 23), and other applicable regulations must be demonstrated by the performance test.

(3) The Board may require a performance test in any case where it is necessary to determine the compliance status for a facility. However, the Board will not request a performance test for any facility which is known to be in compliance with the allowable opacity limitation.

(4) All alternate visible emission limits shall be established on a source or facility-specific basis. No limitation for any facility or source shall be established by reference to a similar or identical facility or source.

(5) The owner or operator of the source or facility shall notify the Board at least fifteen days prior to conducting a test for the purposes of demonstrating an alternate visible emission limit.

(6) A staff member who is a qualified observer, approved by the Board or other consultant approved by the Board shall be present during any performance tests.

(7) The cost of the performance test shall be at the expense of the owner or operator.

(8) Any alternate visible emission limit established for any source or facility shall not become effective until said limitation is established in the applicable operating permit. Said limitation will be incorporated, by amendment, into the operating permit for said source or facility and submitted to the U.S. EPA as a SIP revision.

(9) Where a visible emission limitation is based upon a New Source Performance Standard, any new limitation must comply with the provisions of said standard.

Sec. 6. Compliance Timetables—Sources newly subject to more stringent limitations at the promulgation date of this Rule *[325 IAC 5-1]* by Section 2 *[325 IAC 5-2-1]* shall comply with the compliance schedule of 325 IAC 6-1 (formerly known as APC 23).

Sec. 7. SIP Revision—Any exemptions given or provisions granted to this rule *[325 IAC 5-1]* by the Board in Sections 3 (c) *[325 IAC 5-3-2(c)]* or 5(b) *[325 IAC 5-1-5(b)]* shall be submitted to the U.S. EPA as revisions to the State Implementation Plan.

ARTICLE 6. PARTICULATE REGULATIONS

Rule 1. Nonattainment Area Limitations

Sec. 1. Applicability. Sources or facilities specifically listed in Appendix A *[325 IAC 6-1-7]* of this Rule shall comply with the limitations contained therein. Sources or facilities that are (1) located in the nonattainment counties listed in Appendix A *[325 IAC 6-1-7]*, (2) but which sources or facilities are not specifically listed in Appendix A *[325 IAC 6-1-7]*, and (3) have the potential to emit 100 tons or more of particulate matter per year or have actual emissions of 10 tons or more of particulate matter per year, shall comply with the limitations of Section 2 *[325 IAC 6-1-2]*, hereof.

Sec. 2. Emission Limitations. (a) General Sources—Facilities not limited by paragraphs (b) through (g) below shall not allow or permit discharge to the atmosphere any gases which contain particulate matter in excess of 0.07 gram per dry standard cubic meter (g/dscm) (0.03 grain per dry standard cubic foot (dscf)). Where this limitation is more stringent than the applicable limitations of paragraphs (b) through (g) of this section, for facilities in existence prior to the applicability dates, or of a size not applicable to said paragraphs, emission limitations for those facilities shall be determined by the Board and will be established in accordance with the procedures set forth in paragraph (h) of this section.

(b) Fuel Combustion Steam Generators—No person shall operate a fossil fuel combustion steam generator (any furnace or boiler used in the process of burning solid, liquid, or gaseous fuel or any combination thereof for the purpose of producing steam by heat transfer) so as to discharge or cause to be discharged any gases unless such gases are limited to:

(1) A particulate matter content of no greater than 0.18 grams per million calories (0.10 pounds per million Btu) for solid fuel fired generators of greater than 63 million kilocalories (kcal) per hour heat input (250 million Btu);

(2) A particulate matter content of no greater than 0.63 grams per million calories (0.35 pounds per million Btu) for solid fuel fired generators of equal to or greater than 6.3 but less than or equal to 63 million kcal per hour heat input (25 but less than or equal to 250 million Btu);

(3) A particulate matter content of no greater than 1.08 grams per million calories (0.6 pounds per million Btu) for solid fuel fired generators of less than 6.3 million kcal per hour heat input (25 million Btu);

(4) A particulate matter content of no greater than 0.27 grams per million kcal (0.15 pounds per million Btu) for all liquid fuel fired steam generators.

(5) A particulate matter content of no greater than .01 grains per dry standard cubic foot for all gaseous fuel-fired steam generators.

(c) Aspalt Concrete Plants—The requirements of this provision shall apply to any asphalt concrete plant (any facility used to manufacture asphalt concrete by heating and drying aggregate and mixing with asphalt cement). An asphalt concrete plant is deemed to consist only of the following: driers, systems for screening, handling, storing, and weighing hot aggregate; systems for loading, transferring, and storing mineral filler; systems for mixing asphalt concrete; and the loading, transfer, and storage systems associated with emission control systems.

(1) No person shall operate the affected facilities of an asphalt concrete plant which existed on or prior to June 11, 1973, so as to discharge or cause to be discharged into the atmosphere any gases unless such gases are limited to:

(A) A particulate matter content of no greater than 230 mg per dscm (0.10 grain per dscf).

(d) Grain Elevators—No person shall operate a grain elevator (a grain elevator is defined as any plant or installation at which grain is unloaded, handled, cleaned, dried, stored or loaded) without meeting the provisions of this Section. Paragraph (1) below shall apply to any grain storage elevator located at any grain processing source which has a permanent

Rule 2. [Repealed]

Rule 2.1. Particulate Emission Limitations for Sources of Indirect Heating

Sec. 1. Applicability. This rule establishes limitations for sources of indirect heating. (a) Particulate emissions from the combustion of fuel for indirect heating from all facilities located in Lake, Porter, Marion, Boone, Hamilton, Hendricks, Johnson, Morgan, Shelby, and Hancock Counties which were existing and in operation or which received permit to construct prior to the effective date of this rule (325 IAC 6-2.1) shall be limited by section 2 below.

(b) Particulate emissions from the combustion of fuel for indirect heating from all facilities not specified in (a) which were existing and in operation or which received permits to construct prior to the effective date of this rule (325 IAC 6-2.1) shall be limited by section 3 below.

(c) Particulate emissions from the combustion of fuel for indirect heating from all facilities receiving permits to construct on or after the effective date of this rule (325 IAC 6-2.1) shall be limited by section 4 below.

(d) If any limitation established by this rule (325 IAC 6-2.1) is inconsistent with applicable limitations contained in 325 IAC 6-1, then the limitations contained in 325 IAC 6-1 prevail.

(e) If any limitation established by this rule (325 IAC 6-2.1) is inconsistent with applicable limitations contained in 325 IAC article 12.1 (New Source Performance Standards) then the limitations contained in 325 IAC article 12.1 prevail.

(f) If any limitation established by this rule (325 IAC 6-2.1) is inconsistent with a limitation contained in a facility's construction or operation permit as issued pursuant to 325 IAC article 2 (Permit Review Regulations), then the limitations contained in the source's current permits prevail.

(g) If any limitation established by this rule (325 IAC 6-2.1) is inconsistent with a limitation required by 325 IAC article 2 (Permit Review Regulations) to prevent a violation of the Ambient Air Quality Standards set forth in 325 IAC 1.1-3, then the limitations required by 325 IAC article 2 prevail.

(h) The addition of a new facility at a source does not affect the limitations of the existing facilities unless such changes in the limitations are required by the provisions of 325 IAC article 2 or 325 IAC 6-1.

Sec. 2. Emission limitations for facilities specified in 325 IAC 6-2.1-1(a). (a) Particulate emissions from existing indirect heating facilities located in the specified counties shall be limited by the following equation:

$$Pt = \frac{0.87}{Q^{0.16}}$$

Where:
Pt = Pounds of particulate matter emitted per million Btu (lb/mmBtu) heat input.
Q = Total source maximum operating capacity rating in million Btu per hour (mmBtu/hr) heat input. The maximum operating capacity rating is defined as the maximum capacity at which the facility is operated or the nameplate capacity, whichever is specified in the facility's operation permit application, except when some lower capacity is contained in the facility's operation permit, in which case, the capacity specified in the operation permit shall be used.

For Q less than 10 mmBtu/hr, Pt shall not exceed 0.6.

For Q greater than or equal to 10,000 mmBtu/hr, Pt shall not exceed 0.2. Figure 1 may be used to estimate allowable emissions.

(b) The emission limitations for those indirect heating facilities which were existing and in operation on or before June 8, 1972, shall be calculated using the equation contained in subsection 2(a) where: Q shall reflect the total source capacity on June 8, 1972. The resulting Pt is the emission limitation for each facility existing on that date and will not be affected by the addition of any subsequent facility. The particulate emissions from all of the facilities which were in existence on June 8, 1972, may be allocated in any way among these facilities provided that they will not result in a significantly greater air quality impact level at any receptor than that which would result if the particulate emissions from each of these facilities were limited to Pt; and provided that the emission limitations for each facility are specified in its operation permit. Significant impact levels are defined in 325 IAC 2-3, section 2(d).

(c) The emission limitations for those indirect heating facilities which began operation after June 8, 1972, and before the effective date of this rule (325 IAC 6-2.1), and those facilities which receive permits to construct prior to the effective date of this rule (325 IAC 6-2.1) shall be calculated using the equation contained in subsection 2(a) where: Q includes the capacity for the facility in question and the capacities for those facilities which were previously constructed or received prior permits to construct. The limitations for all previously permitted facilities do not change. The Q and Pt for each facility at a source which begins operation or receives a construction permit during this time period will be different.

Sec. 3. (a) Particulate emissions from indirect heating facilities existing and in operation before the effective date of this rule shall be limited by the following equation:

$$Pt = \frac{C \times a \times h}{76.5 \times Q^{0.75} \times N^{0.25}}$$

Where:
C = Maximum ground level concentration with respect to distance from the point source at the "critical" wind speed for level terrain. This shall equal 50 micrograms per cubic meter (ug/m³) for a period not to exceed a 60-minute time period.
Pt = Pounds of particulate matter emitted per million Btu heat input (lb/mmBtu).
Q = Total source maximum operating capacity rating in million Btu per hour (mmBTU/hr) heat input. The maximum operating capacity rating is defined as the maximum capacity at which the facility is operated or the nameplate capacity, whichever is specified in the facility's operation permit application, except when some lower capacity is contained in the facility's operation permit; in which case, the capacity specified in the operation permit shall be used.
N = Number of stacks in fuel burning operation.
a = Plume rise factor which is used to make allowance for less than theoretical

plume rise. The value 0.67 shall be used for Q less than or equal to 1,000 mmBtu/hr heat input. The value 0.8 shall be used for Q greater than 1,000 mmBtu/hr heat input.

h = Stack height in feet. If a number of stacks of different heights exist, the average stack height to represent "N" stacks shall be calculated by weighing each stack height with its particulate matter emission rate as follows:

$$h = \frac{\sum_{i=1}^{N} H_i \times pa_i \times Q_i}{\sum_{i=1}^{N} pa_i \times Q_i}$$

Where:

pa=the actual controlled emission rate in lb/mmBtu using the emission factor from AP-42 or stack test data. Stacks constructed after January 1, 1971 shall be credited with GEP stack height only. GEP stack height shall be calculated as specified in rule 325 IAC 1.1-6.1

(b) The emission limitations for those indirect heating facilities which were existing and in operation on or before June 8, 1972, shall be calculated using the equation contained in subsection 3(a) where: Q, N, and h shall include the parameters for all facilities in operation on June 8, 1972. The resulting Pt is the emission limitation for each facility existing on that date and will not be affected by the addition of any subsequent facility. The particulate emissions from all of the facilities which were in existence on June 8, 1972, may be allocated in any way among these facilities provided that they will not result in a significantly greater air quality impact level at any receptor than that which would result if the particulate emissions from each of these facilities were limited to Pt; and provided that the emission limitations for each facility are specified in its operation permit. Significant impact levels are defined in 325 IAC 2-3 section 2(d).

(c) The emission limitations for those indirect heating facilities which began operation after June 8, 1972, and before the effective date of this rule (325 IAC 6-2.1), and those facilities which receive permits to construct prior to the effective date of this rule (325 IAC 6-2.1) shall be calculated using the equation contained in subsection 3(a) where: Q, N, and h shall include the parameters for the facility in question and for those facilities which were previously constructed or received prior permits to construct. The limitations for all previously permitted facilities do not change. The Q, N, h, and Pt for each facility at a source which begins operation or receives a construction permit during this time period will be different.

(d) Particulate emissions from all facilities used for indirect heating purposes which were existing and in operation on or before June 8, 1972, shall in no case exceed 0.8 lb/mmBtu heat input.

(e) Particulate emissions from any facility used for indirect heating purposes which has 250 mmBtu/hr heat input or less and which began operation after June 8, 1972, shall in no case exceed 0.6 lb/mmBtu heat input.

Sec. 4. Emission limitations for facilities specified in 325 IAC 6-2.1-1(c) (a) Particulate emissions from indirect heating facilities constructed after the effective date of this rule (325 IAC 6-2.1) shall be limited by the following equation:

$$Pt = \frac{1.09}{Q^{0.26}}$$

Where:

Pt = Pounds of particulate matter emitted per million Btu (lb/mmBtu) heat input.

Q = Total source maximum operating capacity rating in million Btu per hour (mmBtu/hr) heat input. The maximum operating capacity rating is defined as the maximum capacity at which the facility is operated or the nameplate capacity, whichever is specified in the facility's permit application, except when some lower capacity is contained in the facility's operation permit; in which case, the capacity specified in the operation permit shall be used.

For Q less than 10 mmBtu/hr, Pt shall not exceed 0.6.

For Q greater than or equal to 10,000 mmBtu/hr, Pt shall not exceed 0.1. Figure 2 may be used to estimate allowable emissions.

(b) As each new indirect heating facility is added to a plant Q will increase. As a result, the emission limitation for each progressively newer facility will be more stringent until the total plant capacity reaches 10,000 mmBtu/hr after which the emission limit for each newer facility will be 0.1 lb/mmBtu heat input. The rated capacities for facilities regulated by article 12.1, New Source Performance Standards, shall be included when calculating Q for subsequent facilities.

Rule 3. Process Operations

Sec. 1. Applicability—This Rule *[325 IAC 6-3]* establishes emission limitations *for particulate emissions from process* operations located anywhere in the State. The following processes and their attendant emissions are exempt from this Rule *[325 IAC 6-3]*:

(1) Combustion for indirect heating
(2) Incinerators
(3) Open burning
(4) Existing Foundry Cupolas

If any limitation established by this Rule *[325 IAC 6-3]* is inconsistent with applicable limitations contained in 325 IAC 6-1 (formerly known as APC 23), or contained in 325 IAC, Article 12 (New Source Performance Standards), then the limitation contained herein shall not apply; but the limit in such sections shall apply.

Sec. 2. Emission Limitations. (a) Cement Kilns—No owner or operator of a cement manufacturing operation commencing operation prior to December 6, 1968, equipped with electrostatic precipitators, bag filters or equivalent gas-cleaning devices shall cause, allow or permit any discharge to the atmosphere any gases containing particulate matter in excess of:

(1) $E = 8.6\ P^{0.67}$, below 30 tons per hour of process weight;

(2) $E = 15.0\ P^{0.50}$, over 30 tons of process weight.

Where E = emission rate in pounds/hour and P = process weight in tons/hour.

(b) Catalytic Cracking Units—The owner or operator of a catalytic cracking unit commencing operation prior to December 6, 1968, and which is equipped with cyclone separators, electrostatic precipitators, or other gas-cleaning systems shall recover 99.97% or more of the circulating catalyst or total gas-borne particulate.

(c) Process Operations—No person shall operate any process so as to produce, cause, suffer or allow particulate matter to be emitted in excess of the amount shown in the following table.

Allowable Rate of Emission Based on Process Weight Rate[1]

Process Weight Rate		Rate of Emission	Process Weight Rate		Rate of Emission
Lbs/Hr	Tons/Hr	Lbs/Hr	Lbs/Hr	Tons/Hr	Lbs/Hr
100	0.05	0.551	16,000	8.00	16.5
200	0.10	0.877	18,000	9.00	17.9
400	0.20	1.40	20,000	10.00	19.2
600	0.30	1.83	30,000	15.00	25.2
800	0.40	2.22	40,000	20.00	30.5
1,000	0.50	2.58	50,000	25.00	35.4
1,500	0.75	3.38	60,000	30.00	40.0
2,000	1.00	4.10	70,000	35.00	41.3
2,500	1.25	4.76	80,000	40.00	42.5
3,000	1.50	5.38	90,000	45.00	43.6
3,500	1.75	5.96	100,000	50.00	44.6
4,000	2.00	6.52	120,000	60.00	46.3
5,000	2.50	7.58	140,000	70.00	47.8
6,000	3.00	8.56	160,000	80.00	49.0
7,000	3.50	9.49	200,000	100.00	51.2
8,000	4.00	10.40	1,000,000	500.00	69.0
9,000	4.50	11.20	2,000,000	1,000.00	77.6
10,000	5.00	12.00	6,000,000	3,000.00	92.7
12,000	6.00	13.60			

[1] Interpolation of the data in this table for process weight rates up to 60,000 lbs/hr shall be accomplished by use of the equation:

$$E = 4.10\ P^{0.67}$$

and interpolation and extrapolation of the data for process weight rates in excess of 60,000 lbs/hr shall be accomplished by use of the equation:

$$E = 55.0\ P^{0.11} - 40$$

where E = rate of emission in lbs/hr and
P = process weight in tons/hr

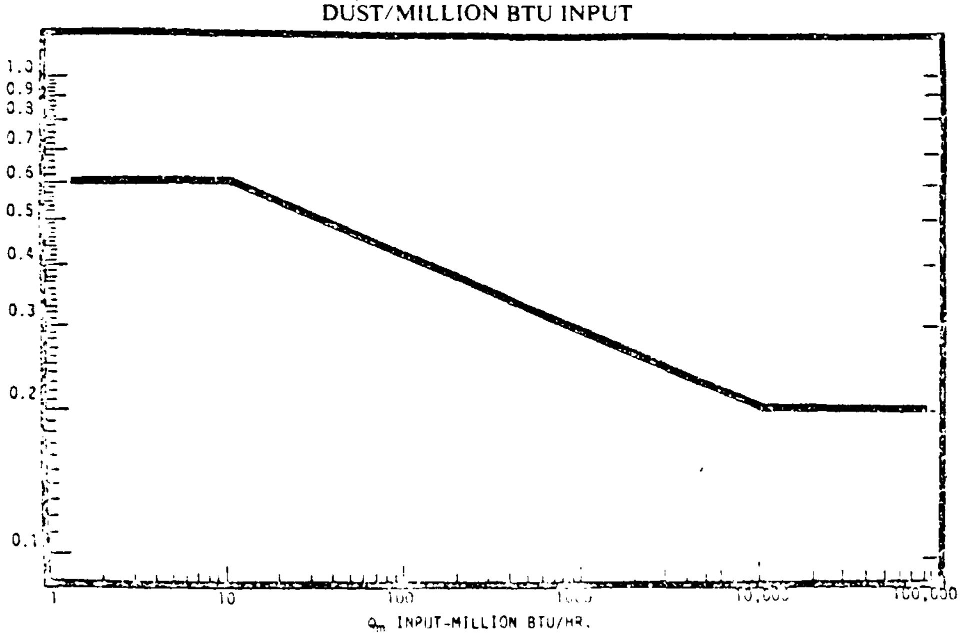
When the process weight exceeds 200 tons/hour, the maximum allowable emission may exceed that shown in the table, provided the concentration of particulate matter in the discharge gases to the atmosphere is less than 0.10 pounds per 1,000 pounds of gases at standard conditions.

Rule 4. Fugitive Dust Emissions

Sec. 1. Applicability—This Rule *[325 IAC 6-4]* shall apply to all sources of fugitive dust. For the purposes of this Rule *[325 IAC 6-4]*, "fugitive dust" means the generation of particulate matter to the extent that some portion of the material escapes beyond the property line or boundaries of the property, right-of-way, or easement on which the source is located.

Sec. 2. Allowable Emissions—A source or sources generating fugitive dust shall be

Pt, ALLOWABLE POUNDS
DUST/MILLION BTU INPUT



Q_m INPUT-MILLION BTU/HR.

PARTICULATE EMISSION LIMITS

FIGURE 1

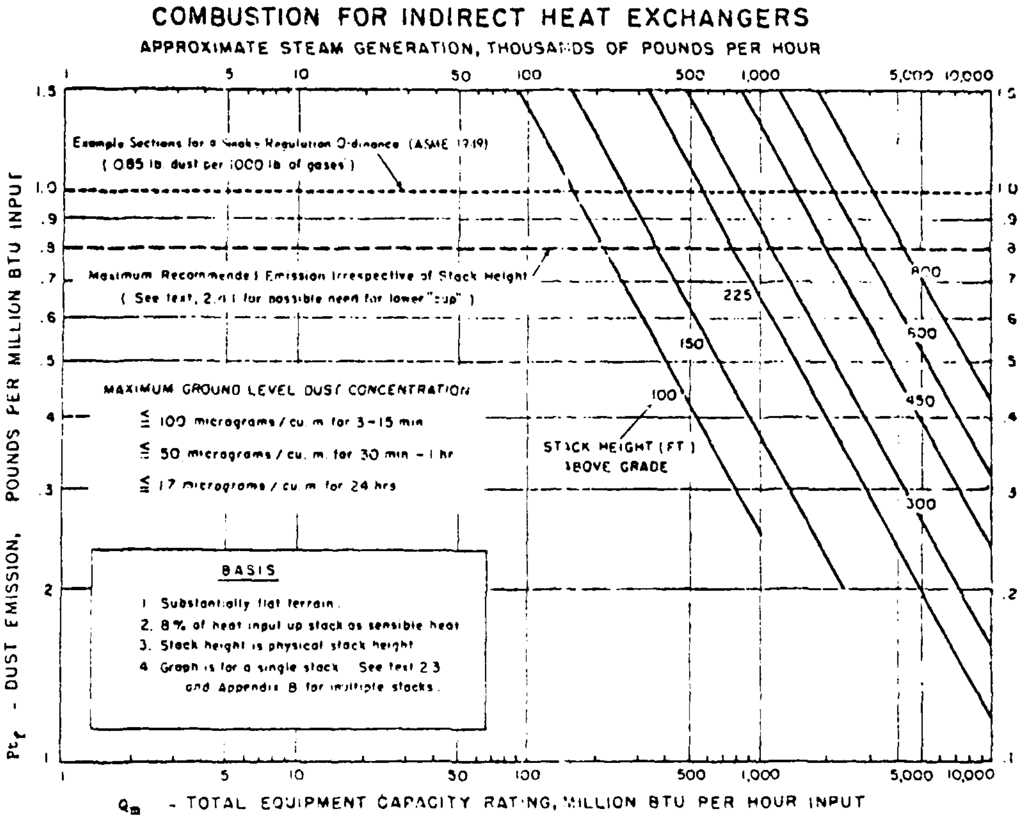


Figure 2
ASME STANDARD - GUIDE FOR CONTROL OF DUST EMISSION

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APPENDIX C
Plant Operating Logs

STEAM BOILER PLANT OPERATING LOG

1. COMMAND	2. BASE AND LOCATION	3. BUILDING NO. AND NAME	4. DATE
SAC	[illegible] AFB [illegible] 46971	223 [illegible]	8 Mar 88

FUEL USED D: COAL - BTU/LB; OIL - BTU/GAL; GAS - BTU/1000CF

FLUE GAS E: TEMP (Degree F) 160

C. Steam Produced – Boiler No. 4	D. Fuel Used – Boiler No. 4	E. O_2 or CO_2 (Avg %) – Boiler No. 4	E. Temp – Boiler No. 4	F. Fuel Oil Press (PSIG)	F. Fuel Oil Temp (°F)	G. Feedwater Heater Press (PSIG)	G. Feedwater Heater Temp (°F)	H. Feedwater Flow Start	H. Stop	H. Gals	I. Make Up Water Flow Start	I. Stop	I. Gals	J. Condensate Return Temp (°F)	K. Feedwater Pump Suct.	K. Disch.	L. Outside Temperature (°F)
5620	6400	11.5	540			4	218			6940	450	458	500	165		205	38
57600	6900	12.0	570			4	218			6940		461	390	165		205	38
59200	6578	12.0	570			4	218			7132		465	400	165		205	38
51200	6578	11.5	540			4	218			7132		469	400	165		205	38
51200	6578	11.5	540			4	218			7132		472	500	165		205	38
51600	6651	11.0	570			4	218			7190		476	400	165		205	38
61200	6800	12.5	560			4	218			7373		481	500	165		205	38
62400	6710	13.0	560			4	218			7518		486	500	165		205	38
476400	52675	95.0	4350			32	1744			57357			3540	1320		1640	304
59500	6584	11.9	545			4	218			7170			318	165		205	38
60800		11.5	560			4	218			7325		490	400	165		205	40
60500		11.5	560			4	218			7325		495	500	165		205	46
59200		12.5	560			4	218			7133		502	700	165		205	54
62900		12.0	530			4	218			7518		506	400	165		205	60
60800		13.2	560			4	218			7235		512	600	165		205	68
57200		12.0	560			4	218			7133		518	600	165		205	70
56900		13.0	560			4	218			6943		523	500	165		205	76
51200		12.0	560			4	218			6169		530	700	165		205	76
471200	52356	11.5	4480			32	1744			56771			820	1320		1640	490
58100	6544	12.1	560			4	218			7096			103	165		205	61
44000	4731	10.5	520			4	218			5307	530	536	600	160		205	65
46400	4980	10.5	520			4	218			5590		542	600	160		205	62
46400	4989	10.5	520			4	218			5590		545	500	160		205	60
46400	4989	10.5	520			4	218			5590		548	300	160		205	56
44800	4817	10.5	500			4	218			5348		554	400	160		205	58
50400	5419	11.5	510			4	218			6072		557	500	160		205	[illegible]
51200	5305	12.0	520			4	218			6162		561	400	160		205	52
44400	4781	12.0	520			4	218			5590		565	600	160		205	48
376000	40425	33.0	4130			32	1744			45299		3500	3021	1280		1640	505
47000	5054	11.0	516			4	217			5662			275	160		205	63
323000	14565	27.5	1292			16	5232			15540			6321	532		1120	1291
5533	6061	11.6	540			4	218			6613			266	163		205	54

OPERATING DATA

	#5 FIRST SHIFT	SECOND SHIFT	THIRD SHIFT	TOTAL
	415865	491775	496965	[illegible]
	474460	485865	491775	[illegible]
		471200	376000	1323199
	0150-0453	1100-1405	2010-2317	[illegible]
	TIME 0200 GALS 220+840=1060	TIME 1400 GALS 220+3330=3550	TIME — GALS 1409+315=479	5119
	Col Wrenn Mcc CT Dave W	Shelda, Bonney, Cherry Richards, Wilson	Leach, D Giaan, Dotson Cox, Brown	[illegible]
ON	40	40	40	120

WC-GG-DA 0610
ASHES 0520-0730 = 840

WC+GG-DA 0800
ASHES 0800-1600

WC+GG-DA

BLOWDOWN #1 - 30 SEC.

Bilo. -1600-1620
2130-2215

660

Boiler 1025-1500

ID Valve 5 Closed Jack-2nd Board

11500

SIGNATURE OF CHIEF OPERATING ENGINEER

6. PLANT COMBUSTION EFFICIENCY (Percent)	11. MAKEUP WATER (Percent)
79.5%	4.0%
7. PLANT BTU OUTPUT (Millions)	12. TOTAL FUEL USED
1325105406	72.7 TNS
	COAL - LBS. 145459
8. PLANT BTU INPUT (Millions)	
1816237500	OIL - GALS. —
9. OVERALL EFFICIENCY (Percent)	
72.8%	GAS - MCF —
10. PEAK DEMAND FACTOR (Percent)	
95.9%	

[illegible] EDITION WILL BE USED

DAILY STEAM BOILER PLANT OPERATING LOG

1. COMMAND: SAC
2. BASE AND LOCATION: GRIFFIN K921
3. BUILDING NO. AND NAME: 225 BC HP
4. DATE: 9 MAR 83

TIME HOUR (A)	STEAM PRESS (PSIG) (B)	STEAM PRODUCED (1000 Pounds) (C) Boiler No. 3	FUEL USED (D) Boiler No. 3	FLUE GAS (E) O_2 or CO_2 (Avg %) Boiler No. 3	FLUE GAS (E) Temp (Degree F) 458 Boiler No. 3	FUEL OIL (F) Press (PSIG)	FUEL OIL (F) Temp (°F)	FEEDWATER HEATER (G) Press (PSIG)	FEEDWATER HEATER (G) Temp (°F)	FEEDWATER FLOW (Gals) (H) Start	FEEDWATER FLOW (H) Stop	FEEDWATER FLOW (H) Gals	MAKE-UP WATER FLOW (Gals) (I) Start	MAKE-UP (I) Stop	MAKE-UP (I) Gals	CONDENSATE RETURN TEMP (°F) (J)	FEEDWATER PUMP PRESSURES (PSIG) (K) Suct.	FEEDWATER PUMP (K) Disch.	OUTSIDE
06:30	113	51200	5505	11.5	540			4	216			6162	565	570	500	165		205	9
07:30	113	51200	5505	11.5	540			4	217			6162		575	500	165		205	7
[illegible]	113	[illegible]	5161	11.0	540			4	216			5783		575	410	165		205	7
[illegible]	113	49600	5333	11.5	540			4	218			5475		582	400	165		205	4
[illegible]	113	52000	5505	12.2	540			4	218			6162		586	400	165		205	4
[illegible]	113	52000	5505	12.0	540			4	218			[illegible]		590	400	165		205	4
[illegible]	113	52400	6021	12.0	540			4	218			6796		594	400	165		205	4
[illegible]	113	52400	6021	10.0	540			4	218			6796		599	500	165		205	4
[illegible]	114	56000	44559	91.5	4330			32	1744			49922			3400	1320		1640	33
TOTAL	994	414400	5569	11.4	540			4	218			6240			425	165		205	4
AVG	111	51800	7111	11.5	540			4	218			5312	599	604	1000	165		205	4
08:30	118	64000	7466	11.0	540			4	216		8016	5526		610	100	165		205	4
09:30	100	67200	6933	10.0	540			4	216			5179		612	200	165		205	3
10:30	106	62400	6933	10.0	540			4	216			5179		616	400	165		205	3
11:30	105	67400	7111	10.0	540			4	216			7711		622	600	165		205	3
12:30	105	64000	6933	11.0	540			4	216			7518		627	500	165		205	3
13:30	105	62400	6710	11.5	540			4	216			7518		632	500	165		205	3
14:30	105	62400	6156	11.5	540			4	216			7325		638	200	165		205	3
15:30	105	60800	56178	91.5	4331			32	1730		43796	50916			320	1320		1640	31
TOTAL	739	502600	7022	11.8	540			4	216		7130	[illegible]			40	165		205	3
AVG	105	63300	6933	11.5	540			4	220			5177	638	643	500	160		205	3
16:30	105	62400	6882	12.5	540			4	220			7711		647	400	160		205	3
17:30	105	61000	6538	11.5	540			4	220			7325		653	600	160		205	3
18:30	105	60800	6796	11.5	540			4	220			7615		657	500	160		205	3
19:30	105	63200	6798	11.5	540			4	220			7615		662	400	160		205	3
20:30	105	63200	7022	12.0	540			4	220			7747		667	500	160		205	3
21:30	105	61600	6710	12.0	540			4	220			7218		671	400	160		205	3
22:30	105	63300	6776	12.0	540			4	220			7615		676	500	160		205	3
23:30	105	61200	53425	95.6	4330			4	220			59326			1770	1280		1640	30
TOTAL	840	496200	6689	11.9	540			32	1760			7166			221	160		205	3
AVG	105	62000	159212	93.5	13360			4	220			170163			5490	3920		4920	7
DAILY TOTAL	2533	1,415,222	6426	11.4	540			96	5284			7112			229	163		205	4
DAILY AVG	110	58967			.12			4	218										

OPERATING DATA

5.	FIRST SHIFT	SECOND SHIFT	THIRD SHIFT	TOTAL
A. STEAM FLOW FINAL (Integrator)	501256	501856	513998	1,415,200
B. STEAM FLOW START	496460			
C. TOTAL STEAM PRODUCED	411,122			
D. LBS STEAM PER UNIT OF FUEL	0555-0663	1338	2025	6910
E. SOOT BLOWN	TIME 0600 GALS [illegible]	TIME: 1400 GALS 2204 1340 3580	TIME: — GALS — 2030	
F. BLOW DOWN				
G. DEGREE DAY				
H. OPERATOR	[illegible]	SCHEALO CHERRY WILSON BONNER	Gooch Brown Ot Carrol	
I. FIREMAN			24	
J. TOTAL MANHOURS OPERATION	32	32		
13. REMARKS (Continue on reverse)	WC-CC 0000 Ashes-CCE-800 1050	WC+CC 0800 ASHES 0800-1600	WC+GG · DA 1625 Ashes-1600-1925-1435 2315-2340-595	12,400

6. PLANT COMBUSTION EFFICIENCY (Percent): 80%

7. PLANT BTU OUTPUT (Millions): 1,417,237,888

8. PLANT BTU INPUT (Millions): 1,927,650,000

9. OVERALL EFFICIENCY (Percent): 73.5%

10. PEAK DEMAND FACTOR (Percent): 103.4%

11. MAKEUP WATER (Percent): 3.2%

12. TOTAL FUEL USED

COAL - LBS. Tons 77.10 [illegible] 154 [illegible]

OIL - GALS. ______

GAS - MCF ______

DATE | SIGNATURE OF CHIEF OPERATING ENGINEER

AF FORM 1458 OCT 81 PREVIOUS EDITION WILL BE USED.

DAILY STEAM BOILER PLANT OPERATING LOG

1. COMMAND: SAC
2. BASE AND LOCATION: GRISSOM AFB IND 46971
3. BUILDING NO. AND NAME: 322 BCHD
4. DATE: 10 [illegible]

Shift	Time Hour (A)	Steam Press (PSIG) (B)	Steam Produced (1000 Pounds) (C) Boiler 1	C Boiler 2	C Boiler 3	C Boiler 5	Fuel Used (D) (Coal – BTU/LB; Oil – BTU/GAL; Gas – BTU/1000CF) Boiler 1	D Boiler 2	D Boiler 3	D Boiler 5	Flue Gas (E) O_2 or CO_2 (Avg %) Boiler 1	O_2/CO_2 Boiler 2	O_2/CO_2 Boiler 3	O_2/CO_2 Boiler 5	Temp (Degree F) 453 Boiler 1	Temp Boiler 2	Temp Boiler 3	Temp Boiler 5	Fuel Oil (F) Press (PSIG)	Fuel Oil Temp (°F)	Feedwater Heater (G) Press (PSIG)	Feedwater Heater Temp (°F)	Feedwater Flow (Gals) (H) Start	H Stop	H Gals	Make-up Water Flow (Gals) (I) Start	I Stop	I Gals	Condensate Return Temp (°F) (J)	Feedwater Pump Pressures (PSIG) (K) Suct.	K Disch.	Outside
First Shift	0030	105				59200				6366				12.0				540			4	218			7133	676	681	500	160		205	3[illegible]
	0130	105				57200				6166				12.0				540			4	218			7133		686	500	160		205	3[illegible]
	0230	105				60800				6538				11.5				540			4	218			7325		692	600	160		205	3[illegible]
	0330	105				62400				6710				12.0				540			4	218			7518		696	400	160		205	3[illegible]
	0430	105				62400				6710				12.0				540			4	218			7518		699	300	160		205	[illegible]
	0530	105				64000				6882				12.5				540			4	218			7711		702	300	160		205	32
	0630	105				65600				7054				12.5				540			4	218			7904		708	600	160		205	30
	0730	106				62400				6710				12.0				540			4	218			7518		714	600	160		205	30
	TOTAL	841				496800				53336				96.5				4320			32	1744			59760		5800	3265	1280		1640	25
	AVG	105				62000				6667				12.1				540			4	218			7470		—	409	160		205	32
Second Shift	0830	106				64000				7111				11.5				540			4	218			5312	714	717	300	160		205	3[illegible]
	0930	105				64000				7111				13.5				540			4	218			5312		721	400	160		205	3[illegible]
	1030	106				65600				7288				13.0				540			4	218			5444		724	300	160		205	4[illegible]
	1130	106				62400				6933				12.5				540			4	218			7518		731	700	160		205	6[illegible]
	1230	104				62400				6933				12.5				540			4	218			7518		737	600	160		205	6[illegible]
	1330	105				61600				6844				12.0				540			4	218			7423		743	600	160		205	66
	1430	105				62900				8067				12.0				540			4	218			9398		747	400	160		205	66
	1530	105				56000				6222				12.0				540			4	218			6747		753	600	160		205	6[illegible]
	TOTAL	845				498400				55378				99				4330			32	1744			60048			2225	1280		1640	42
	AVG.	106				62300				6922				12.4				540			4	218			7506			278	160		205	5[illegible]
Third Shift	1630	105				56000				6022				12.0				530			4	220			6747	753	759	600	160		205	66
	1730	122				56000				6022				12.0				520			4	220			6747		765	600	160		205	53
	1830	105				59200				6366				12.5				520			4	220			7133		769	400	160		205	4[illegible]
	1930	105				59200				6366				12.5				520			4	220			7153		779	800	160		205	4[illegible]
	2030	105				59100				6366				12.5				520			4	220			7133		779	0	160		205	[illegible]
	2130	105				59200				6366				12.5				520			4	220			7133		781	400	160		205	[illegible]
	2230	105				61600				6442				13.0				510			4	220			7711		[illegible]	[illegible]	160		205	[illegible]
	2330	105				62400				6709				12.5				520			4	220			7518		791	500	160		205	7[illegible]
	TOTAL	840				475200				51096				99.5				4170			32	1760			57253			2110	1280		1640	37
	AVG	105				59400				6387				12.4				521			4	220			7156			264	160		205	46
Daily	TOTAL	2526				1469600				158021				295				12810			96	5248			177060			7600	3840		4920	105
	AVG.	105				61233				6584				12.2				533			4	218			7377			317	160		205	44

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5. OPERATING DATA

	FIRST SHIFT	SECOND SHIFT	THIRD SHIFT	TOTAL
A. STEAM FLOW FINAL (Integrator)	520175	526446	532412	[illegible]
B. STEAM FLOW START	513998	520175	526446	[illegible]
C. TOTAL STEAM PRODUCED	496 000	498400	1469600	1469600
D. LBS. STEAM PER UNIT OF FUEL				
E. SOOT BLOWN	0515	1237	2035	
F. BLOW DOWN	TIME: 0200 GALS. 220+315=535	TIME: 1400 GALS. 220+1455=1675	TIME: 2000 GALS. 220+1470=1690	3900
G. DEGREE DAY				
H. OPERATOR	Richard · McPherson · Wrenn · Toner	Schebelo · Cherry · Wilson · Conner	Aboch · Brown · McGown	
I. FIREMAN				
J. TOTAL MANHOURS OPERATION	32	32	24	88
13. REMARKS (Continue on reverse)	NC+GG 0035 ASHES 0640-0725=315	WC+GG 0800 → ASHES – 1045-1600 POOL 1315-1505	WC+GG ASHES 1600-1800 840 2130-2300-630	11,500

Blowdown #1, 4

FIRE IN #3 @ 1630 HRS.

6. PLANT COMBUSTION EFFICIENCY (Percent): 83.5

7. PLANT BTU OUTPUT (Millions): 1471716224

8. PLANT BTU INPUT (Millions): 1975262500

9. OVERALL EFFICIENCY (Percent): 74.5%

10. PEAK DEMAND FACTOR (Percent): 96 %

11. MAKEUP WATER (Percent): 4.2 %

12. TOTAL FUEL USED: 79 tns

COAL - LBS. 158021

OIL - GALS. ______

GAS - MCF ______

DATE | SIGNATURE OF CHIEF OPERATING ENGINEER

AF FORM OCT 82 1458 PREVIOUS EDITION WILL BE USED.

DAILY STEAM BOILER PLANT OPERATING LOG

1. COMMAND: SAC
2. BASE AND LOCATION: GAFB Ind 43071
3. BUILDING NO. AND NAME: 223 BCHP
4. DATE: 11 Mar 85

Shift	A. Time Hour	B. Steam Press (PSIG)	C. Steam Produced (1000 Pounds) Boiler No. 5	D. Fuel Used Boiler No. 5	E. Flue Gas O_2 or CO_2 (Avg %) Boiler No. 5	E. Flue Gas Temp (Degree F) 455 Boiler No. 5	G. Feedwater Heater Press (PSIG)	G. Feedwater Heater Temp (°F)	H. Feedwater Flow (Gals) Gals	I. Make Up Water Flow (Gals) Start	I. Stop	I. Gals	J. Condensate Return Temp (°F)	K. Feedwater Pump Pressures (PSIG) Disch	L. Outside Temperature (°F)
First Shift	0030	105	64227	6682	12.0	540	6	214	7711	741	776	500	165	205	38
	0130	105	64000	6882	12.0	540	6	214	7711		778	200	165	205	38
	0230	105	67000	6882	12.5	540	6	214	7711		803	500	165	205	36
	0330	105	64200	6882	12.5	540	6	214	7711		806	300	165	205	37
	0430	105	64800	6882	12.5	540	6	214	7711		811	600	165	205	37
	0530	105	64500	7167	12.0	540	6	214	7771		813	300	165	205	34
	0630	105	68800	7644	12.0	540	6	214	8281		818	500	165	205	34
	0730	105	65800	7377	11.5	532	6	214	[illegible]		[illegible]	300	165	205	32
	TOTAL	840	533100	56134	15.5	4330	48	1712	[illegible]			3200	1320	1640	272
	AVG	105	65262	7017	11.9	540	6	214	7863			400	165	205	34
Second Shift	0830	103	61000	7778	11.5	540	6	214	[illegible]	823	825	200	165	205	34
	0930	104	70000	7778	12.0	540	6	214	8134		828	300	165	205	34
	1030	104	61000	7111	12.0	540	6	214	5312		832	400	165	205	38
	1130	104	64000	7111	12.0	540	6	214	6312		836	400	165	205	43
	1230	106	672001	7467	12.0	540	6	214	8072		844	800	165	205	43
	1330	106	67200	7467	12.0	540	6	214	8096		848	700	165	205	54
	1430	104	56000	6222	12.0	540	6	214	6747		852	480	165	205	64
	1530	105	57800	6311	11.0	540	6	214	6812		856	400	165	201	64
	TOTAL	840	506200	56244	95.5	4320	48	1712	60988			245	1320	1640	368
	AVG	105	63275	7031	11.9	540	6	214	7623			31	165	205	46
Third Shift	1630	105	54400	5889	11.5	520	4	219	6554	856	862	600	165	205	64
	1730	105	56000	6222	12.0	522	4	215	6747		869	700	165	205	60
	1830	105	57000	6222	12.0	520	4	215	6747		874	500	165	205	56
	1930	105	58400	6200	12.0	530	4	212	7036		879	500	165	205	52
	2030	105	56000	6022	11.0	520	4	212	6747		884	500	165	205	52
	2130	105	57100	6194	11.0	520	4	218	6940		886	400	165	205	50
	2230	105	60000	6452	12.0	530	4	218	7229		893	500	165	205	52
	2330	105	57000	6022	12.0	530	4	218	6747		898	500	165	205	50
	TOTAL	840	454800	48266	9.5	4170	32	1744	54147		[illegible]	2105	1320	[illegible]	[illegible]
	AVG	105	56900	6107	10.1	524	4	218	6813			301	165	205	48
Daily	TOTAL	2520	1482700	161110	32.5	[illegible]	128	5165	177263			2330	3960	[illegible]	[illegible]
	AVG	105	61779	6717	11.3	535	5	215	7443			244	165	205	43

OPERATING DATA

	FIRST SHIFT	SECOND SHIFT	THIRD SHIFT	TOTAL
STEAM FLOW FINAL (Integrator)	532436	545147	550832	[illegible]
STEAM FLOW START	532412	532835	545147	[illegible]
TOTAL STEAM PRODUCED	533100	506200	454400	1482700
LBS STEAM PER UNIT OF FUEL				
SOOT BLOWN	[illegible] 0508	940	2005-2012	
BLOW DOWN	TIME 0210 GALS 220+55/215	TIME: GALS 2204235	TIME: 2000 GALS 220115	~~5575~~ 5550
DEGREE DAY				
OPERATOR	[illegible] Larsen Wrenn	CHERRY - WILSON - [illegible]	McGowan Brown Cox	
FIREMAN	V[illegible]			
TOTAL MANHOURS OPERATION	24	24	24	72
REMARKS (Continue on reverse)	WC GG DA - 0210 Ashes - 0015 - 0730 - 525	WC + GG + DA 0810 ASHES 845-1530 pool on at 845-1925	WC + GG + DA Ashes - 1800-1945 2130-2330	11,400

8. PLANT COMBUSTION EFFICIENCY (Percent): 80%

11. MAKEUP WATER (Percent): 3.2%

7. PLANT BTU OUTPUT (Millions): 1484835056

12. TOTAL FUEL USED: 806 TNS.

COAL - LBS. 14199

6. PLANT BTU INPUT (Millions): 2014057500

OIL - GALS. ______

9. OVERALL EFFICIENCY (Percent): 73.6%

GAS - MCF ______

10. PEAK DEMAND FACTOR (Percent): 107.6%

2921

DATE

SIGNATURE OF CHIEF OPERATING ENGINEER

FORM OCT 82 1458 PREVIOUS EDITION WILL BE USED.

DAILY STEAM BOILER PLANT OPERATING LOG

1. COMMAND	2. BASE AND LOCATION	3. BUILDING NO. AND NAME	4. DATE
SAC	[illegible]	223 PUMP	12 [illegible]

COAL - BTU/LB; OIL - BTU/GAL; GAS - BTU/1000CF

Time Hour (A)	Steam Press (PSIG) (B)	Steam Produced (1000 Pounds) (C) Boiler 1	Boiler 2	Boiler 3	Boiler 5	Fuel Used (D) Boiler #3	Boiler 2	Boiler 3	Boiler 5	Flue Gas (E) O_2 or CO_2 (Avg %) Boiler 1	Boiler 2	Boiler 3	Boiler 5	Flue Gas Temp (Degree F) 110 Boiler 1	Boiler 2	Boiler 3	Boiler 5	Fuel Oil (F) Press (PSIG)	Temp (°F)	Feedwater Heater (G) Press (PSIG)	Temp (°F)	Feedwater Flow (Gals) (H) Start	Stop	Gals	Make Up Water Flow (Gals) (I) Start	Stop	Gals	Condensate Return Temp (°F) (J)	Feedwater Pump Pressures (PSIG) (K) Suct.	Disch.	Outside Temperature (°F) (L)
[illegible]	105				56000				1022[illegible]				11.0				520			4	218			6717	[illegible]	902	400	165		205	50
2228	105				56000				6622				11.0				510			4	218			6247		907	500	170		205	50
[illegible]30	105	5000		12000	33600	44.2		1333	5733	10.5		8.5	9.5			380	460			4	218			6096		910	300	170		205	50
[illegible]	105	12000		22000	28800	166		3444	5096	10.5		9.0	9.0			420	410			4	218			7469		915	500	170		205	50
[illegible]	105	15000		35000		159		3111		10.5		10.5				480				4	218			5542		920	500	170		205	30
0530	120	[illegible]		[illegible]		231		3333		10.5		17.5				520				4	218			[illegible]		925	500	170		205	54
[illegible]30	[illegible]	28000		37000		247		3222		12.0		12.0				540				4	218			[illegible]		[illegible]	700	170		205	44
0730	[illegible]	26000		37000		230		3333		10.5		10.0				540				4	218			6088		940	800	170		205	46
TOTAL	837	114000		174000	177400	1069		16555	18752	73.6		61.5	40.3			3880	1970			32	1744			52600			2558	1355		1640	371
AVG	105	19000		21833	43600	168		2759	4688	10.6		10.2	10.1			480	490			4	218			6575			320	169		205	49
0830	105	16000		40000		142		4444		10.5		12.0				540				4	218			6797	940	948	500	170		205	46
0930	105	17000		53000		159		4222		10.5		12.0				540				4	218			6747		948	900	170		205	50
1030	105	18000		45000		248		3111		10.5		10.5				540				4	218			8795		952	900	170		205	50
1130	100	21500	9000	47000		243	80	3006		11.0		10.5				540				4	218			8133		958	600	170		205	50
1230	50	21500	9000	31000		243	80	3006		11.0		10.0				540				4	218			8133		962	400	170		205	60
1330	80	27000	9000	32000		234	80	2667		11.0		10.0				570				4	218			8313		968	600	170		205	60
1430	80	22000	6000	30000		239	88	1333		11.0		10.0				540				4	218			8072		972	400	170		205	60
1530	100	25000	20000	16000		204	177	1777		11.0		10.0				540				4	218			7108		980	600	170		205	60
TOTAL	725	194000	52000	264000		1717	505	29333		86.5		85				4300				33	1744			62048			3380	1360		1640	436
AVG	91	24250	11400	33000		215	101	3667		10.8		10.6				540				4	218			7756			423	170		205	55
[illegible]30	151	25000	11000	20000		221	123	2222		13.5	9.0	7.0			440	410				4	218			7108	980	992	500	160		205	54
[illegible]30	103	21000	20000	18000		212	176	3000		12.0	10.5	8.5			540	460				4	218			7470		997	400	160		205	47
[illegible]30	103	24000	21000	11000		212	185	1122		13.5	11.0	9.0			540	440				4	218			6747		994	700	160		205	42
[illegible]30	103	25000	22000	15000		221	174	1667		12.0	10.5	9.5			540	430				4	218			7470		998	400	160		205	40
2030	110	28000	21000	14400		221	185	1518		11.0	11.0	9.5			410	440				4	218			7277		002	400	160		205	38
2130	105	25000	17000	23000		221	168	2444		11.0	11.0	10.0			410	420				4	218			7552		006	400	160		205	38
2230	105	22000	19000	27000		194	168	2667		11.5	11.0	11.0			460	500				4	218			7631		011	500	160		205	35
2330	105	22000	19000	24000		171	168	2667		11.5	11.0	11.0			460	500				4	218			7531		017	600	160		205	35
TOTAL	[illegible]	193000	155000	[illegible]		[illegible]	1372	16489		98.8	85.0	75.5			3820	3340				32	1744			59786		3700	3420	1320		1640	335
AVG	105	24000	19375	12500		212	172	2061		12.3	10.6	9.4			478	458				4	218			747			428	160		205	42
DAILY TOTAL	2104	500000	212155	561600	177400	4440	1877	62376	18752	248	950	222	40.9		3820	10840	1970			96	5232			174434			9357	4000		4920	1162
DAILY AVG	100	22727	16320	25525	44300	202	144	2535	4688	11.2	10.6	10.0	10.1		478	494	490			4	218			7265			390	167		205	48

5. OPERATING DATA

	First Shift #1	#3	#5	Second Shift 1	2	3	Third Shift			Total
A. Steam Flow Final (Integrator)	872171	112521	553195	896239	718439	117566	829618	721293	120027	735800
B. Steam Flow Start	830242	107EF9	550832	892171	718003	112520	896339	718439	117566	712155
C. Total Steam Produced	114000	149000	177100	191000	57000	264000	192000	155000	148100	1447955
D. Lbs. Steam per Unit of Fuel										
E. Soot Blown							2030-2015			
F. Blow Down	Time 0205	Gals 2704 1412 1642		Time	Gals 420		Time	Gals 2801		2342
G. Degree Day										
H. Operator	[illegible]			Ryan, Wilson, Derrick			McGowan, Brown, Cox			
I. Fireman	[illegible]									
J. Total Manhours Operation	24			24			24			72

13. REMARKS (Continue on reverse)

WC-GG 0210
ASHES - 0545 - 0715 650
Up DOWN #5 = 792

WC+GC
ASHES 1400 4300

WC + GG-DA
Ashes - 2200 - 2240

HANGER 200, OPEN 1800

6. PLANT COMBUSTION EFFICIENCY (Percent): (1) 82.5% (3) 82% (5) 87%

7. PLANT BTU OUTPUT (Millions): 1456,040,055

8. PLANT BTU INPUT (Millions): 1974295110

9. OVERALL EFFICIENCY (Percent): 73.4%

10. PEAK DEMAND FACTOR (Percent): 55.8%

11. MAKEUP WATER (Percent): 53%

12. TOTAL FUEL USED: 406TNS.
1014,111,110
COAL - LBS. 81128
960181,000
OIL - GALS. 6317
GAS - MCF

DATE: [illegible]

SIGNATURE OF CHIEF OPERATING ENGINEER

AF FORM 1458 OCT 61 PREVIOUS EDITION WILL BE USED.

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DAILY STEAM BOILER PLANT OPERATING LOG

1. COMMAND: SAC
2. BASE AND LOCATION: GAFB IN 46971
3. BUILDING NO. AND NAME: 223 BchP
4. DATE: [illegible]

C = STEAM PRODUCED (1000 Pounds); D = FUEL USED (COAL – BTU/LB, OIL – BTU/GAL, GAS – BTU/1000CF); E = FLUE GAS (O_2 OR CO_2 (Ave %), TEMP) 40 259 432

Shift	TIME HOUR A	STEAM PRESS (PSIG) B	C Boiler 1	C Boiler 2	C Boiler 3	C Boiler 4	D Boiler 1	D Boiler 2	D Boiler 3	D Boiler 4	E O_2/CO_2 Boiler 1	E Boiler 2	E Boiler 3	E Boiler 4	E Temp Boiler 1	E Temp Boiler 2	E Temp Boiler 3	E Temp Boiler 4
FIRST SHIFT	0030	112	30	-	30		265	-	3333		11.0	-	13.0		500	-	500	
	0130	105	30	11	26		265	97	2889		11.0	11.0	11.0		500	340	500	
	0230	105	27	11	26		239	97	2889		10.0	10.0	11.0		500	340	500	
	0330	105	27	11	30		239	97	3333		11.5	10.0	10.5		500	340	500	
	0430	105	28	11	29		248	97	3333		11.5	10.0	10.5		500	340	500	
	0530	105	29	11	30		257	97	3333		11.0	10.0	11.0		510	340	500	
	0630	105	32	11	31		283	97	3444		11.5	10.0	11.5		520	340	500	
	0730	105	29	9	31		257	80	3444		12.0	10.0	12.0		500	340	500	
	TOTAL	847	232000	75000	233000		2053	662	25887		89.5	70.0	89.6		4000	2380	4000	
	AVG.	106	29000	10711	2925		257	95	3236		11.2	10.0	11.2		500	340	500	
SECOND SHIFT	0830	105	32000	9000	35000		293	88	3656		11.0	9.0	12.5		500	320	540	
	0930	100	27000	10000	39000		239	89	4292		11.0	9.0	11.0		500	320	540	
	1030	104	27000	10000	38000		219	88	4222		11.5	10.0	12.0		500	320	520	
	1130	103	27000	10000	38000		219	99	4222		11.5	10.0	12.5		500	320	520	
	1230	102	27000	10000	38000		239	88	4222		11.5	10.0	13.0		500	320	540	
	1330	100	20000	11000	38000		266	97	4222		11.5	10.0	12.5		500	320	540	
	1430	104	25000	10000	38000		221	88	4222		11.0	10.0	13.0		500	320	540	
	1530	100	27000	10000	38000		239	88	4222		11.0	10.0	13.0		500	320	540	
	TOTAL	817	222000	81000	299000		1965	717	33111		91.0	80.0	101.5		4000	2560	4280	
	AVG.	102	27750	10125	37250		246	90	4139		11.4	10.0	12.7		500	320	535	
THIRD SHIFT	1630	105	28	15	30		248	133	3333		11.5	11.5	12.0		500	360	520	
	1730	105	27	16	27		218	142	3000		11.5	11.5	12.0		500	400	500	
	1830	106	26	16	27		230	142	3000		11.0	11.0	12.0		500	400	500	
	1930	106	23	18	28		204	159	3111		11.0	11.5	12.5		500	410	510	
	2030	106	22	18	28		195	159	3111		11.5	11.5	12.5		500	420	510	
	2130	104	26	18	27		230	157	3000		12.0	11.0	14.0		500	400	490	
	2230	105	28	19	29		218	168	3222		12.0	11.5	13.0		500	400	490	
	2330	105	24	17	28		212	160	3111		12.0	11.5	13.0		500	400	490	
	TOTAL	845	205000	138000	224000		1815	1230	24888		92.5	91.0	100.0		4000	3200	4010	
	AVG.	106	25625	17250	28000		227	154	3111		11.6	11.4	12.5		500	400	501	
DAILY	TOTAL	2509	654000	294000	755000		5833	2609	83886		273.0	241.0	291.0		12000	8140	12290	
	AVG.	105	27458	12250	31458		243	109	3495		11.4	10.0	12.1		500	339	512	

F = FUEL OIL; G = FEEDWATER HEATER; H = FEEDWATER FLOW (Gals); I = MAKE UP WATER FLOW (Gals); J = CONDENSATE RETURN TEMP (°F); K = FEEDWATER PUMP PRESSURES (PSIG); L = OUTSIDE TEMPERATURE

Shift	TIME HOUR A	F PRESS (PSIG)	F TEMP (°F)	G PRESS (PSIG)	G TEMP (°F)	H START	H STOP	H GALS	I START	I STOP	I GALS	J	K SUCT.	K DISCH.	L
FIRST SHIFT	0030			4	218			7229	017	20	300	160		205	18
	0130			4	216			8022		22	200	160		205	36
	0230			4	218			7911		33	1100	160		205	34
	0330			4	218			8193		38	500	160		205	32
	0430			4	218			9193		43	510	160		205	30
	0530			4	218			8434		47	400	160		205	30
	0630			4	218			8316		50	300	160		205	30
	0730			4	218			8313		53	100	160		205	30
	TOTAL			32	1744			65061		3600	2309	1280		1640	260
	AVG.			4	218			8133		—	289	160		205	33
SECOND SHIFT	0830			4	218			8916	053	061	800	160		205	30
	0930			4	218			9036		069	800	160		205	30
	1030			4	219			9036		074	600	160		205	30
	1130			4	216			9036		079	400	160		205	30
	1230			4	218			9076		083	500	160		205	30
	1330			4	219			9518		087	1100	160		205	30
	1430			4	218			8795		093	600	160		205	30
	1530			4	218			9036		097	400	160		205	30
	TOTAL			32	1744			72410			3839	1280		1640	240
	AVG.			4	218			9051			480	160		205	30
THIRD SHIFT	1630			4	216			8775	097	102	600	165		205	32
	1730			4	216			8557		108	600	165		205	31
	1830			4	218			8313		113	500	165		205	30
	1930			4	210			8313		117	400	165		205	30
	2030			4	210			8193		121	400	165		205	30
	2130			4	218			8552		127	600	165		205	30
	2230			4	216			9167		132	500	165		205	30
	2330			4	218			8134		137	500	165		205	30
	TOTAL			32	1744			68313			3790	1310		1640	243
	AVG.			4	218			8539			474	165		205	30
DAILY	TOTAL			96	5232			205784			9930	3550		4920	743
	AVG.			4	218			8574			414	162		205	31

OPERATING DATA .80 .80 .80

	FIRST SHIFT			SECOND SHIFT			THIRD SHIFT			TOTAL
1. STEAM FLOW FINAL (Integrator)	903979	721517	124440	908176	721517	129993	912085	724144	134204	#1 - 654,000
STEAM FLOW START	877618	721293	121527	903974	721517	124440	908176	721517	129993	#2 - 294,000
TOTAL STEAM PRODUCED	232000	75000	233000	222000	81000	299000	205,000	138,000	224,000	#3 - 755,000
LBS. STEAM PER UNIT OF FUEL										Total - 1,708,000
SOOT BLOWN	0545	0550	0553			1100	2010 - 2015 - 2030			
BLOW DOWN	TIME 0200	GALS. 352+940=1292		TIME 1400	GALS. 352+210=562		TIME —	GALS. 210		
DEGREE DAY										
OPERATOR	Richard Tiner Wittenbrink			Schiebl - Bonner - Kichiels			Gooch Cox			
FIREMAN										
TOTAL MANHOURS OPERATION	24			24			16			64

REMARKS (Continue on reverse)

WC + GG 0030
ASHES 0600 0640 >280
HANGER 200 0700
BLOWDOWN #4 60 SEC 660

WC + GG + DA 0915
ASHES - 1000 1315
1015 1330
105 + 105
HANGER 200-1415
Blowdown #5 FOR 180 Sec. 2300 Gals.

WC + GG + DA 1625
ASHES - 2200-2230
210 GALS

DATE | SIGNATURE OF CHIEF OPERATING ENGINEER

6. PLANT COMBUSTION EFFICIENCY (Percent): 83.5% - 82% - 81.6%
7. PLANT BTU OUTPUT (Millions): 1,710,459,520
8. PLANT BTU INPUT (Millions): 2,331,759,000
9. OVERALL EFFICIENCY (Percent): 73.4%
10. PEAK DEMAND FACTOR (Percent): 55.5%
11. MAKEUP WATER (Percent): 4.8%
12. TOTAL FUEL USED
Tons 41.943
COAL - LBS. 83886
1,048,575,000
OIL - GALS. 8142
1,283,184,000
GAS - MCF ——

FORM 1458 OCT 82 PREVIOUS EDITION WILL BE USED.

APPENDIX D
Coal Analysis

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CORE LABORATORIES

CORE LABORATORIES, INC.

ANALYTICAL REPORT

2315 GLENVIEW AVE.
EVANSVILLE, IN 47712
(812) 424-2909

13-APR-88

DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA041188
SAMPLE NO. : 0001
INVOICE JOB #: C88434
LOCATION #: 63120

IDENTIFICATION
CAN #5004
BOILER # 5
RUN 1
BYPASS

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	12.78	5.82	---
% ASH	5.90	6.37	6.76
% VOLATILE	32.79	35.40	37.59
% FIXED CARBON	48.53	52.41	55.65
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.74	0.80	0.85
BTU/LB.	11,906	12,857	13,651
MAF BTU/LB.	---	---	14,641
LBS SULFUR/MM BTU	0.62		
LBS WATER/MM BTU	10.73		
LBS ASH/MM BTU	4.96		

REDUCING ASH FUSION: 2700+ DEGREES F

RESPECTFULLY SUBMITTED,

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KEVIN J. WEIL

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305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA041188
SAMPLE NO. : 0002
INVOICE JOB #: C88434
LOCATION #: 63120

IDENTIFICATION
CAN # 5005

BOILER #5
RUN 2
BYPASS

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	13.93	6.39	---
% ASH	5.37	5.84	6.24
% VOLATILE	32.04	34.85	37.23
% FIXED CARBON	48.66	52.92	56.53
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.71	0.77	0.82
BTU/LB.	11,799	12,833	13,709
MAF BTU/LB.	---	---	14,621
LBS SULFUR/MM BTU	0.60		
LBS WATER/MM BTU	11.81		
LBS ASH/MM BTU	4.55		

REDUCING ASH FUSION: 2700+ DEGREES F

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305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA041188
SAMPLE NO. : 0003
INVOICE JOB #: C88434
LOCATION #: 63120

IDENTIFICATION

CAN # 5007
BOILER #5
RUN 3
BYPASS

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	12.58	6.02	---
% ASH	6.17	6.63	7.06
% VOLATILE	32.94	35.41	37.68
% FIXED CARBON	48.31	51.93	55.26
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.79	0.85	0.90
BTU/LB.	11,883	12,775	13,593
MAF BTU/LB.	---	---	14,625
LBS SULFUR/MM BTU	0.66		
LBS WATER/MM BTU	10.59		
LBS ASH/MM BTU	5.19		

REDUCING ASH FUSION: 2700+ DEGREES F

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DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA041188
SAMPLE NO. : 0004
INVOICE JOB #: C88434
LOCATION #: 63120

IDENTIFICATION

CAN # 5009

BOILER #5
RUN 1
SCRUBBER

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	12.42	5.32	---
% ASH	6.46	6.99	7.38
% VOLATILE	33.04	35.71	3 .72
% FIXED CARBON	48.08	51.98	54.90
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.83	0.90	0.95
BTU/LB.	11,896	12,860	13,583
MAF BTU/LB.	---	---	14,664
LBS SULFUR/MM BTU	0.70		
LBS WATER/MM BTU	10.44		
LBS ASH/MM BTU	5.43		

REDUCING ASH FUSION: 2700+ DEGREES F

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DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA041188
SAMPLE NO. : 0005
INVOICE JOB #: C88434
LOCATION #: 63120

IDENTIFICATION

CAN # 5011

BOILER #5
RUN 2
SCRUBBER

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	14.37	5.25	---
% ASH	5.67	6.27	6.62
% VOLATILE	33.67	37.26	39.32
% FIXED CARBON	46.29	51.22	54.06
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.72	0.80	0.84
BTU/LB.	11,743	12,994	13,714
MAF BTU/LB.	---	---	14,685
LBS SULFUR/MM BTU	0.61		
LBS WATER/MM BTU	12.24		
LBS ASH/MM BTU	4.83		

REDUCING ASH FUSION: 2700+ DEGREES F

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305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA041188
SAMPLE NO. : 0006
INVOICE JOB #: C88434
LOCATION #: 63120

IDENTIFICATION

CAN # 5012

BOILER #5
RUN 3
SCRUBBER

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	12.97	5.46	---
% ASH	5.76	6.26	6.62
% VOLATILE	32.89	35.73	37.79
% FIXED CARBON	48.38	52.55	55.59
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.75	0.81	0.86
BTU/LB.	11,888	12,914	13,660
MAF BTU/LB.	---	---	14,627
LBS SULFUR/MM BTU	0.63		
LBS WATER/MM BTU	10.91		
LBS ASH/MM BTU	4.84		

REDUCING ASH FUSION: 2700+ DEGREES F

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DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA041188
SAMPLE NO. : 0007
INVOICE JOB #: C88434
LOCATION #: 63120

IDENTIFICATION

CAN # 5013
BOILER #3
RUN 1
SCRUBBER

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	13.53	5.51	---
% ASH	6.04	6.60	6.98
% VOLATILE	33.01	36.07	38.17
% FIXED CARBON	47.42	51.83	54.85
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.73	0.79	0.84
BTU/LB.	11,785	12,878	13,629
MAF BTU/LB.	---	---	14,651
LBS SULFUR/MM BTU	0.62		
LBS WATER/MM BTU	11.48		
LBS ASH/MM BTU	5.12		

REDUCING ASH FUSION: 2700+ DEGREES F

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DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA041188
SAMPLE NO. : 0008
INVOICE JOB #: C88434
LOCATION #: 63120

IDENTIFICATION
CAN # 5014
BOILER #3
RUN 2
SCRUBBER

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	14.14	6.07	---
% ASH	5.57	6.10	6.49
% VOLATILE	32.18	35.20	37.48
% FIXED CARBON	48.11	52.63	56.03
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.72	0.79	0.84
BTU/LB.	11,749	12,853	13,684
MAF BTU/LB.	---	---	14,634
LBS SULFUR/MM BTU	0.61		
LBS WATER/MM BTU	12.03		
LBS ASH/MM BTU	4.74		

REDUCING ASH FUSION: 2700+ DEGREES F

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GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA041188
SAMPLE NO. : 0009
INVOICE JOB #: C88434
LOCATION #: 63120

IDENTIFICATION
CAN # 5017
BOILER # 3
RUN 3
SCRUBBER

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	12.69	5.46	---
% ASH	6.26	6.78	7.17
% VOLATILE	33.35	36.11	38.20
% FIXED CARBON	47.70	51.65	54.63
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.78	0.84	0.89
BTU/LB.	11,905	12,891	13,635
MAF BTU/LB.	---	---	14,688
LBS SULFUR/MM BTU	0.66		
LBS WATER/MM BTU	10.66		
LBS ASH/MM BTU	5.26		

REDUCING ASH FUSION: 2700+ DEGREES F

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APPENDIX E

Boiler 3, Scrubber Stack Field Data

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DETERMINATION OF MINIMUM NUMBER OF TRAVERSE POINTS

Stack ID: SCRUBBER A STACK Stack diameter at ports: 5.0 (ft)

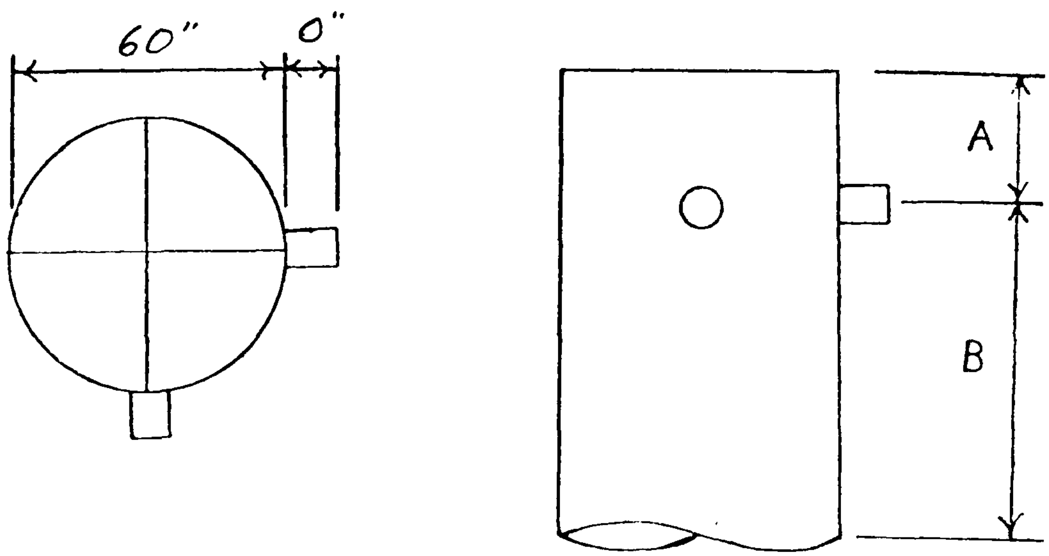
Distance A (ft) 7.0 (duct diameters) 1.4

Recommended number of traverse points as determined by distance A: 20

Distance B (ft) 28 (duct diameters) 5.6

Recommended number of traverse points as determined by distance B: 20

Number of traverse points used: 20



PARTICULATE SAMPLING DATA SHEET

TOTAL WT = 0.1140 gm

RUN NUMBER: B3R1 Scrub	SCHEMATIC OF STACK CROSS SECTION	EQUATIONS
DATE: 13 Mar 88	3 min/pt 20 pt	$°R = °F + 460$
PLANT: heating	Blow start 48 min	$H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Co}\right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$
BASE: Grissom	leak check @ 9"Hg = zero	
SAMPLE BOX NUMBER: RAC	$\sqrt{\Delta P}$ = 9.5564	
METER BOX NUMBER: nuclead	$\bar{T}_s$ = 109	End 276.817
Qw/Qm	$\bar{T}_m$ = 30.7	start 245.295
Co	$\bar{\Delta H}$ = 1.23	
	TOT VOL = 30.922	

AMBIENT TEMP	~25 °F
STATION PRESS	28.933 in Hg
HEATER BOX TEMP	°F
PROBE HEATER SETTING	5
PROBE LENGTH	6' glass in
NOZZLE AREA (A)	.300 sq ft
Cp	.84
DRY GAS FRACTION (Fd)	~8 (est)

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H20)	STACK TEMP (°F)	STACK TEMP (Ts) (°R)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP AVG (Tm) (°R)	GAS METER TEMP OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
10	0930	4	113		.165	1.24	245.295	26		26	220	[illegible]
9	3	4	113		.175	1.32		27		27		
8	6	4	113		.18	1.36		27		26		
7	9	5	113		.18	1.36		29		26	235	
6	12	5	113		.18	1.36		30		27		
5	15	5	113		.175	1.33		31		28	237	20
4	18	5	104		.17	1.31		31		28		
3	21	5	107		.13	1.15		33		28		
2	24	5	107		.13	1.00		34		29		
1	27	5	107		.11	0.85		33		28		
10	1003 30	6	108		.155	1.19	261.265	31		28		
9	3	6	108		.16	1.23		34		30	240	
8	6	6	108		.17	1.31		34		30		
7	9	6.5	108		.17	1.31		35		30	237	
6	12	7	108		.175	1.35		36		30		
5	15	7	108		.17	1.31		37		31		
4	15	7	108		.16	1.24		36		31		
3	21	7.5	108		.155	1.20		36		31		
2	24	7.5	107		.15	1.16		35		31		
1	27	7	107		.14	1.09		37		32		
	30											

PARTICULATE SAMPLING DATA SHEET

TOTAL WT = 0.0525

RUN NUMBER: B3 R2 Scrub	SCHEMATIC OF STACK CROSS SECTION: 3 min/pt 20pt	EQUATIONS: $^oR = ^oF + 460$	AMBIENT TEMP: °F
DATE: 13 Mar 88		$H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Co}\right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$	STATION PRESS: 28.933 in Hg
PLANT: heating		leak chk (a 5.5" Hg zero	HEATER BOX TEMP: °F
BASE: Grissom	2 meter box		PROBE HEATER SETTING:
SAMPLE BOX NUMBER: RAC			PROBE LENGTH: 6' glass in
METER BOX NUMBER: Nutech	PSTS = 9.5161		NOZZLE AREA (A): .360 sq ft
Qw/Qm:	$\bar{T}s$ = 105.3		Cp: .84
Co:	$\bar{T}m$ = 37.0		DRY GAS FRACTION (Fd):
	$\bar{\Delta H}$ = 1.26	end 308.515	
	TOT VOL = 31.41		

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H2O)	STACK TEMP (°F)	STACK TEMP (Ts) (°R)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP AVG (Tm) (°R)	GAS METER TEMP OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
10	1205	.09 Vac 5	110		.16	1.22	277.104	29		29	236	18
9	3	5	110		.175	1.34		32		30	240	
8	[illegible]	5	108		.18	1.38		33		30	238	
7	9	5	103		.185	1.44		35		31	249	25
6	12	5	105		.185	1.44		38		32	243	
5	15	5	107		.19	1.48		39		33		
4	18	5	105		.17	1.33		40		33	236	28
3	21	5	106		.14	1.09		40		33	232	27
2	24	4.5	108		.13	1.01		41		34		
1	27	4	108		.11	0.86		41		35	238	28
10	1240/30	4	108		.13	1.01	292.766	39		36		
9	3	4.5	108		.15	1.17		40		36	232	29
8	6	5	104		.175	1.38		42		36	232	
7		5	104		.175	1.38		43		37	249	23
6	12	5	103		.18	1.42		44		37	256	
5	15	5	103		.18	1.42		43		36	259	24
4	18	5	102		.16	1.27		44		37	267	
3	21	5	101		.16	1.27		44		38	273	30
2	24	5	101		.145	1.15		44		38	268	34
1	27	5	101		.14	1.11		44		38	270	33
	30											

PARTICULATE SAMPLING DATA SHEET

TOTAL WT = 0.1278 gm

RUN NUMBER: B3R3 Scrub	SCHEMATIC OF STACK CROSS SECTION: 3 min/pt 20 pt	EQUATIONS: $^{o}R = {}^{o}F + 460$	AMBIENT TEMP: °F
DATE: 13 Mar 88		$H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Co}\right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$	STATION PRESS: 28.933 in Hg
PLANT: heating			HEATER BOX TEMP: °F
BASE: Grissom	$\bar{P}_{B}$ = 10.3480	@ 5" Hg = [illegible] leak	PROBE HEATER SETTING:
SAMPLE BOX NUMBER: RAC	$\bar{T}_s$ = 105		PROBE LENGTH: 6' glass in
METER BOX NUMBER: Nutech	$\bar{T}_m$ = 38.6		NOZZLE AREA (A): .30 sq ft
Qw/Qm:	$\overline{\Delta H}$ = 1.29		Cp: .84
Co:	TOT VOL = 31.828	end 340.882	DRY GAS FRACTION (Fd): ~ [illegible]

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H2O)	STACK TEMP (°F)	STACK TEMP (Ts) (°R)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP AVG (Tm) (°R)	GAS METER TEMP OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
10	1443	.10 4	110		.13	1.00	309.054	33		33	226	27
9	3	4	110		.165	~~1.20~~ 1.27		35		34	248	29
8	6	4	109		.17	1.32		37		35	251	29
7	9	5	107		.175	1.36		38		34	256	30
6	12	5	107		.18	1.40		39		34	258	28
5	15	5	106		.180	1.40		41		35	262	28
4	18	5	106		.18	1.41		42		35	260	28
3	21	5	105		.165	1.29		42		37		
2	24	5	105		.16	1.26		42		36	268	28
1	27	4.5	104		.14	1.10		43		36	262	30
10	30	5	105		.16	1.25	324.881	41		36	260	30
9	3	5	104		.17	1.34		41		37	258	29
8	6	5	101		.18	1.42		42		36	260	28
7	9	5	101		.185	1.47		44		37	261	29
6	12	5	101		.185	1.47		44		37	259	31
5	15	5	101		.19	1.51		45		38	256	30
4	18	5	102		.17	1.35		44		37	230	30
3	21	4.5	104		.145	1.14		45		37		
2	24	4	106		.13	1.02		46		38	244	32
1	27	4	106		.12	.94		45		38	242	32

OEHL FORM MAY 78 18

PRELIMINARY SURVEY DATA SHEET NO. 2
(Velocity and Temperature Traverse)

BASE	DATE
[illegible]	13 [illegible] 88

BOILER NUMBER

INSIDE STACK DIAMETER 60 Inches

STATION PRESSURE 13.433 In Hg

STACK STATIC PRESSURE 0.09 In H20

SAMPLING TEAM

TRAVERSE POINT NUMBER	VELOCITY HEAD, Vp IN H20	$\sqrt{V_p}$ CYCLONE	STACK TEMPERATURE (°F)
10	~~.13~~ .17	15	112
9	.17	15	112
8	.18	2	111
7	.17	2	111
6	.19	0	110
5	.19	0	110
4	.18	10	111
3	.17	10	110
2	.15	20	110
1	.15	25	110
		avg = 9.9	
AVERAGE			

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE	DATE	RUN NUMBER
	13 MAR 88	~~B3R3~~ B3R1

BUILDING NUMBER	SOURCE NUMBER

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER 12	0.3805	0.2867	0.0938
ACETONE WASHINGS (Probe, Front Half Filter) BEAKER # 55	100.0700	100.0498	0.0202
BACK HALF (If needed)			
	Total Weight of Particulates Collected		0.1140 gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H_2O)	152	100	52
IMPINGER 2 (H_2O)	112	100	12
IMPINGER 3 (Dry)	1	0	1
IMPINGER 4 (Silica Gel)	208.70	203.25	5.5
	Total Weight of Water Collected		70.5 gm

III. GASES (Dry)

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2	6.0	6.2	6.2		6.1
VOL % O_2	13.6	13.5	13.5		13.5
VOL % CO					
VOL % N_2					

Vol % N_2 = (100% - % CO_2 - % O_2 - % CO)

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE	DATE	RUN NUMBER
	13 MAR 84	B3R2

BUILDING NUMBER	SOURCE NUMBER

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER 13	0.3236	0.2867	0.0369
ACETONE WASHINGS *(Probe, Front Half Filter)* BEAKER # 6F	102.3552	102.3396	0.0156
BACK HALF *(If needed)*			
	Total Weight of Particulates Collected		0.0525 gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 *(H20)*	151	100	51
IMPINGER 2 *(H20)*	118	100	18
IMPINGER 3 *(Dry)*	3	0	3
IMPINGER 4 *(Silica Gel)*	238.32	203.25	35.1
	Total Weight of Water Collected		107.1 gm

III. GASES *(Dry)*

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2	6.0	6.0	6.0		6.0
VOL % O_2	14.0	14.0	14.0		14.0
VOL % CO					
VOL % N_2					

Vol % N_2 = (100% - % CO_2 - % O_2 - % CO)

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE	DATE	RUN NUMBER
	13 MAR 85	B3R3

BUILDING NUMBER	SOURCE NUMBER

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER 14	0.3210	0.2902	0.0308
ACETONE WASHINGS (Probe, Front Half Filter) BEAKER # 1	98.8548	98.7578	0.0970
BACK HALF (If needed)			
	Total Weight of Particulates Collected		0.1275 gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H20)	140	100	40
IMPINGER 2 (H20)	120	100	20
IMPINGER 3 (Dry)	5	0	5
IMPINGER 4 (Silica Gel)	239.35	204.06	35.3
	Total Weight of Water Collected		100.3 gm

III. GASES (Dry)

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2	60	60	6.2		6.1
VOL % O_2	14.2	14.4	14.2		14.3
VOL % CO					
VOL % N_2					

APPENDIX F
Boiler 5, Bypass Stack Field Data

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DETERMINATION OF MINIMUM NUMBER OF TRAVERSE POINTS

Stack ID: By Pass Stack diameter at ports: 5.5 (ft)

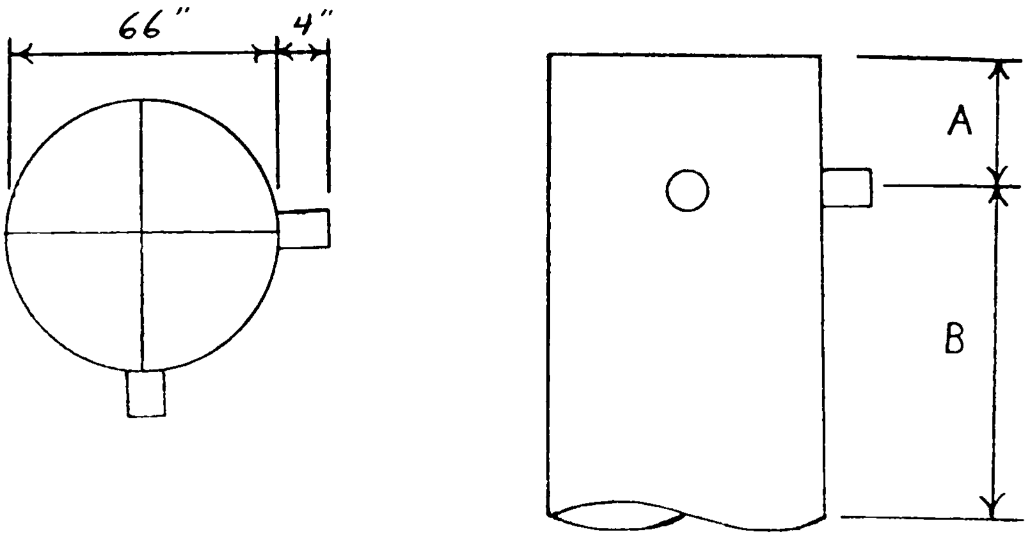
Distance A (ft) 11.5 (duct diameters) 2.1

Recommended number of traverse points as determined by distance A: 12

Distance B (ft) 39.5 (duct diameters) 7.2

Recommended number of traverse points as determined by distance B: 12

Number of traverse points used: 12



PARTICULATE SAMPLING DATA SHEET

TOTAL WT = 0.7042 gr.

RUN NUMBER	B5R1
DATE	8 Mar 88
PLANT	Heating Plant B5 Bypass
BASE	Grissom
SAMPLE BOX NUMBER	RAC
METER BOX NUMBER	Nutech
Qw/Qm	
Co	

SCHEMATIC OF STACK CROSS SECTION

5 min/pt × 12 pt

leak check @ 3" Hg = zero

ΔP TS = 8.7994

T_s = 326

$\bar{T}_m$ = 59.3

ΔH = 1.41

EQUATIONS

$°R = °F + 460$

$$H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Co}\right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$$

$T_{m_{avg}}$ = 59.40

ΔH_{avg} = 1.41

P_{stat} = 8.80

T_s = 326.21

V_m = 33.196

V_{Ti} = 47.05

CO_2 = 10.4

TOT VOL = 33.196

end 938.540

AMBIENT TEMP	34 °F
STATION PRESS	~~29.31~~ 29.188 in Hg
HEATER BOX TEMP	°F
PROBE HEATER SETTING	
PROBE LENGTH	in
NOZZLE AREA ~~(A)~~ D/A	0.374" ~~sq ft~~
Cp	.84
DRY GAS FRACTION (Fd)	~8% (est)

TRAVERSE POINT NUMBER	SAMPLING TIME (min) VAC	STATIC PRESSURE (in H2O) VAC	STACK TEMP (°F)	STACK TEMP (Ts) (°R)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP AVG (Tm) (°R)	GAS METER TEMP OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
6	1100 2	0.09 2	332		0.09	1.26	905.344	55	55	55	236	
	2.5		321		~~0.09~~ 0.1	1.42		55	55.5	56	248	
5	5		325		.12	1.69		57	56.5	56	255	
	~~10~~ 2	2	330		.13	1.83		58	57.5	57		
4	10 2		329		.12	1.69		60	58.5	57	264	56
	~~12~~		331		.12	1.69		60	58.5	57	271	58
3	15 2	2	332		.1	1.41		61	59	57		60
	~~20~~		331		0.09	1.27		60	59	57	271	
2	20 2	2	322		0.09	1.28		60	59	57	256	
	~~25~~		321		.1	1.43		61	59.5	58		
1	25		320		0.08	1.14		61	59.5	58		41
	30		320		.1	1.43		60	59	57	230	
6	1140	3	320		.07	1.00	922.239	58	58	58	237	
	2.5		318		.065	0.93		59	58.5	58		
5	5		318		.07	1.00		59	58.5	58	230	51
	7.5		322		.08	1.14		60	59	58	234	
4	10	3	323		.08	1.14		60	59.5	59	237	52
			327		.085	1.21		61	60	59	234	
3	15		329		.105	1.49		63	61.5	60	230	53
			332		.12	1.69		62	61	60	236	
2	20		334		.12	1.69		64	62.5	61		
			332		.12	1.72		65	63.5	62	240	53
1	25		330		.12	1.70		65	63.5	62		
OEHL FORM MAY 78 18	27.5		323		.11	1.58		65	63.5	62	234	51

PARTICULATE SAMPLING DATA SHEET

TOTAL WT = 0.3785 gr

RUN NUMBER: B5-R 2	SCHEMATIC OF STACK CROSS SECTION	EQUATIONS	AMBIENT TEMP: °F
DATE: 9 Mar 88	5 min/pt 12 pt	$°R = °F + 460$	STATION PRESS: 28.927 in Hg
PLANT: Heating B5 Bypass	Soot blow @ 7.5 min into run	$H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Co}\right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$	HEATER BOX TEMP: °F
BASE: Grissom	(−) 3.1 pitot line check	PSTS = 9.5871	PROBE HEATER SETTING
SAMPLE BOX NUMBER: EAC	(+) 3.7 " "	$\bar{T}_m$ = 49.4	PROBE LENGTH: in
METER BOX NUMBER: Nutech	leak @ 8" Hg = zero	$\bar{T}_s$ = 325	NOZZLE AREA (Diam): .374
Qw/Qm		$\bar{\Delta H}$ = 1.64	Cp: .84
Co		TOT VOL = 35.659	DRY GAS FRACTION (Fd): ~8%
		end 992.324	

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H2O)	STACK TEMP (°F)	STACK TEMP (Ts) (°R)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP AVG (Tm) (°R)	GAS METER TEMP OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
6	1330	0.09 VAC 3	323		0.09	1.22	956.665	41	40.5	40	237	37
	2.5	3	318		0.09	1.25		43	42	41		
5	5	4	320		.105	1.45		45	43	41	260	40
		5	326		.11	1.52		47	44.5	42		
4	10	5	326		.11	1.52		49	46	43	268	40
			329		.11	1.51		50	46.5	43		
3	15	5.5	330		.13	1.80		53	48.5	44	277	45
		6	331		.135	1.86		53	48.5	44		
2	20		332		.14	1.93		55	50	45		47
		6	329		.14	1.95		56	51	46	237	
1	25		329		.14	1.95		57	51.5	46	257	48
		6.5	320		.14	1.97		57	52	47		
6	1410 30	5	320		.1	1.40		50	49	48	256	38
	2.5		318		.11	1.54		50	49	48		
5	5	6	316		.115	1.62		53	50.5	48	258	38
			324		.12	1.68		54	51	48		
4	10		324		.12	1.68		55	51.5	49		
			328		.13	1.81		56	52.5	49		
3	15	7	330		.12	1.67		57	53	49		
			328		.12	1.68		57	53	49		
2	20		326		.12	1.68		57	53	49	259	40
			325		.105	1.47		57	53.5	50		
1	25	7	326		.11	1.54		57	53.5	50	257	39
			326		.11	1.54		57		50		

OEHL FORM MAY 78 18

PARTICULATE SAMPLING DATA SHEET

TOTAL WT = 1.1613

RUN NUMBER	B5R 3
DATE	9 Mar
PLANT	heat B5 Bypass
BASE	Grissom
SAMPLE BOX NUMBER	EAC
METER BOX NUMBER	Nutech
Qw/Qm	
Co	

SCHEMATIC OF STACK CROSS SECTION

5 min/pt 12 pt

Leak check @ 7" = zero

EQUATIONS

$°R = °F + 460$

$$H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Co}\right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$$

PSTS = 9.1249
$\bar{T}_m$ = 51.6
$\bar{T}_s$ = 322
$\bar{\Delta H}$ = 1.50
TOT VOL = 33.943
end 26.458

AMBIENT TEMP	°F
STATION PRESS	28.927 in Hg
HEATER BOX TEMP	°F
PROBE HEATER SETTING	
PROBE LENGTH	in
NOZZLE DIA	.374"
Cp	.84
DRY GAS FRACTION (Fd)	89%

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H20) VAR	STACK TEMP (°F)	STACK TEMP (Ts) (°R)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP AVG (Tm) (°R)	GAS METER TEMP OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
6	1535	.07 2	320		.09	1.25	992.515	46	46	46	266	43
	2.5		320		.08	1.11		47	46.5	46	257	
5	5	3	315		.10	1.40		48	47	46	259	
			319		.10	1.40		50	48	46	261	47
4	10		320		.11	1.54		52	49.5	47	262	48
		3	322		.12	1.68		53	50	47		
3	15		322		.10	1.40		54	50.5	47	263	49
			322		.10	1.40		55	51	47		
2	20	3	323		.10	1.47		56	51.5	48	265	49
			323		.11	1.54		56	52	48		
1	25	4	326		.09	1.26		56	52	48	264	52
			320		.10	1.42		56	52.5	49		
6	1615 30	3	320		.085	1.19		52	50.5	49	269	48
			320		.085	1.19		52	50.5	49		
5	5	4.5	319		.10	1.41		54	52	50	253	51
			324		.09	1.26		55	52.5	50		
4	10	6	324		.10	1.41		57	53.5	50	255	52
			327		.095	1.33		57	53.5	50		
3	15	5.5	326		.125	1.76		58	54.5	51	256	51
			327		.13	1.82		58	54.5	51		
2	20	6	327		.14	1.96		58	54.5	51	255	50
			327		.13	1.83		59	55	51		
1	25	6.5	327		.14	1.97		59	55	51	252	51
		6.5	324		.14	1.98		60	56	52	253	51

OEHL FORM MAY 78 18

4.48 2.11

PRELIMINARY SURVEY DATA SHEET NO. 2
(Velocity and Temperature Traverse)

BASE: Grissom

DATE: 8 Mar 88

BOILER NUMBER: B5 Bypass

INSIDE STACK DIAMETER: 66" Inches

STATION PRESSURE: ~~29.31~~ 29.188 In Hg

STACK STATIC PRESSURE: + 0.09 8% moist In H20

SAMPLING TEAM

TRAVERSE POINT NUMBER	VELOCITY HEAD, V_p IN H20	cyclonic flow	STACK TEMPERATURE (°F)
Port A 1	0.09 21	4	331
2	0.11 23	1	331
3	0.11 23	11	
4	0.13 25	15	
5	0.135 26	15	
6	0.11 23	20	331
Port B 1	24SB	AVG = 11	
2			
3			
4			
5			
6			
actual d	= 0.3982		
	.375, .374, .374		
leak			
+ 2.7" leak check pitot lines			
− 5.7" "	" " "		
AVERAGE			

OEHL FORM 16 APR 78

PRELIMINARY SURVEY DATA SHEET NO. 2

(Velocity and Temperature Traverse)

BASE: Grissom	DATE: 9 Mar
BOILER NUMBER: B5 BYPASS	
INSIDE STACK DIAMETER: 66" Inches	
STATION PRESSURE: 28.927 In Hg	
STACK STATIC PRESSURE: ~~FE~~ 0.09 In H20	
SAMPLING TEAM	

TRAVERSE POINT NUMBER	VELOCITY HEAD, V_p IN H20	$\sqrt{V_p}$ CHYCLONIC	STACK TEMPERATURE (°F)
6	0.08	19	316
5	0.09	15	320
4	0.09	16	318
3	0.11	10	316
2	0.13	0	322
1	0.14	6	323
~~7~~		AVG = 11	
AVERAGE			

OEHL FORM APR 78 16

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE	DATE	RUN NUMBER
GRISSOM	8 Mar 88	1

BUILDING NUMBER	SOURCE NUMBER
Bypass #5	

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER 1	0.5558	0.2842	0.2716
ACETONE WASHINGS *(Probe, Front Half Filter)* BEAKER # 7	97.9631	97.5305	0.4326
BACK HALF *(If needed)*			~~0.7042~~
	Total Weight of Particulates Collected		0.7042 gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 *(H20)*	102.2	100	2.2
IMPINGER 2 *(H20)*	138	100	38
IMPINGER 3 *(Dry)*	5	0	5
IMPINGER 4 *(Silica Gel)*	202.30	200.45	1.85
	Total Weight of Water Collected		47.05 gm

III. GASES *(Dry)*

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2	10.3	10.4	10.4		10.4
VOL % O_2	8.9	8.8	9.0		8.9
VOL % CO					
VOL % N_2					

Vol % N_2 = (100% - % CO_2 - % O_2 - % CO)

OEHL FORM MAY 78 20

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE	DATE	RUN NUMBER
Grissom	9 Mar 88	Run #2 ~~B~~ #3

BUILDING NUMBER	SOURCE NUMBER
Bypass #5	

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER 3	0.6766	0.2872	0.3894
ACETONE WASHINGS (Probe, Front Half Filter) BEAKER #53	105.5764	105.0873	0.4891
BACK HALF (If needed)			
	Total Weight of Particulates Collected		0.8785 gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H20)	128	100	28.0
IMPINGER 2 (H20)	112	100	12.0
IMPINGER 3 (Dry)	1.5	0	1.5
IMPINGER 4 (Silica Gel)	216.65	202.43	14.2
	Total Weight of Water Collected		55.7 gm

III. GASES (Dry)

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2	9.8	10.0	9.8		9.9
VOL % O_2	9.6	9.5	9.6		9.6
VOL % CO					
VOL % N_2					

Vol % N_2 = (100% - % CO_2 - % O_2 - % CO)

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE	DATE	RUN NUMBER
Grissom	9 Mar 88	Run 3 #4

BUILDING NUMBER	SOURCE NUMBER
Boiler 5 Bypass	

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER #4	0.7671	0.2868	0.4803
ACETONE WASHINGS (Probe, Front Half Filter) BEAKER # 60	99.7894	99.1084	0.6810
BACK HALF (If needed)			
	Total Weight of Particulates Collected		1.1613 gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H20)	113	100	13
IMPINGER 2 (H20)	118.5	100	18.5
IMPINGER 3 (Dry)	5	0	5
IMPINGER 4 (Silica Gel)	211.85	200.00	11.85
	Total Weight of Water Collected		48.35 gm

III. GASES (Dry)

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2	9.4	9.4	9.4		9.4
VOL % O_2	10.2	10.2	10.1		10.2
VOL % CO					
VOL % N_2					

$$\text{Vol \% } N_2 = (100\% - \% CO_2 - \% O_2 - \% CO)$$

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APPENDIX G

Boiler 5, Scrubber Stack Field Data

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DETERMINATION OF MINIMUM NUMBER OF TRAVERSE POINTS

Stack ID: SCRUBBER A STACK   Stack diameter at ports: 5.0 (ft)

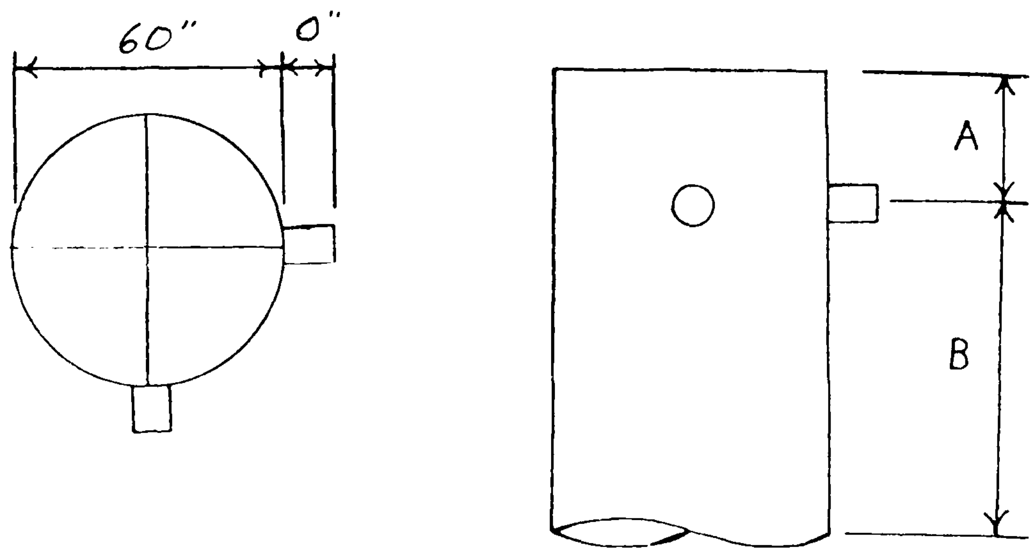
Distance A (ft) 7.0   (duct diameters) 1.4

Recommended number of traverse points as determined by distance A: 20

Distance B (ft) 28   (duct diameters) 5.6

Recommended number of traverse points as determined by distance B: 20

Number of traverse points used: 20



PARTICULATE SAMPLING DATA SHEET

TOTAL WT = 0.0695 gm

RUN NUMBER: B5 R1	SCHEMATIC OF STACK CROSS SECTION	EQUATIONS	AMBIENT TEMP: °F
DATE: 10 Mar 83	3 min/pt 20 pt	$^{o}R = {}^{o}F + 460$	STATION PRESS: 29.046 in Hg
PLANT: heating Scrubber		$H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Co}\right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$	HEATER BOX TEMP: °F
BASE: Grissom	leak @ 6"Hg zero	$\overline{P}_{STS}$ = 12.29	PROBE HEATER SETTING
SAMPLE BOX NUMBER: KAC		$\overline{T}_s$ = 106.5	PROBE LENGTH: glass 6' in
METER BOX NUMBER: Nutech		$\overline{T}_m$ = 45.0	NOZZLE AREA (A): 0.300/.300/.299 sq ft
Qw/Qm		$\overline{\Delta H}$ = 2.12	Cp: .84
Co		TOT VOL = 40.455	DRY GAS FRACTION (Fd): 8% (est)
		end 67.291	

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H20) VAC	STACK TEMP (°F)	STACK TEMP (Ts) (°R)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP AVG (Tm) (°R)	GAS METER TEMP OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
10	1000	.23 5	105		.28	2.20	26.836	40		40	244	16
9	3		105		.30	2.36		41		40		
8	6	5	105		.31	2.44		43		41	259	11
7	9	5	105		.31	2.44		43		40		
6	12	5	105		.30	2.37		44		41	269	10
5	15	5	107		.30	2.31		44		41		
4	18		107		.29	2.28		45		41		10
3	21	5	107		.26	2.05		47		42	263	
2	24		107		.23	1.82		47		42	262	4
1	27	4	107		~~.12~~ .165	~~1.58~~ 1.3		48		42		
10	1033	5	107		.23	1.81	47.6	45		43	261	8
9	3		107		.27	2.13		46		43		
8	6	5	107		.29	2.29		48		43	263	12
7	9	5	107		.295	2.34		49		44		
6	12		107		.30	2.38		52		44	266	30
5	15		107		.29	2.31		52		45		
4	18	5	107		.265	2.11		52		45	262	33
3	21		107		.25	1.99		52		45		
2	24	5	107		.24	1.91		53		46	267	38
1	27	5	107		.19	1.51		53		46	264	
	30											

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31 36 30

1545 1475 265

AGAIN

PARTICULATE SAMPLING DATA SHEET

TOTAL WT = 0.0614 gr

RUN NUMBER	SCHEMATIC OF STACK CROSS SECTION	EQUATIONS	AMBIENT TEMP
B5R2 scrub	3 min/pt 20 pts	$^{o}R = ^{o}F + 460$	31 °F
DATE 11 Mar 88		$H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Co}\right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$	STATION PRESS 29.120 in Hg
PLANT heating	(−) pitot line 4.7		HEATER BOX TEMP °F
BASE Grissom	(+) " " 3.3 Ts = 113.2	Leak check 5" Hg = 3220	PROBE HEATER SETTING
SAMPLE BOX NUMBER RAC	Pres: 10.45 ΔH avg 1.49		PROBE LENGTH 6' glass in
METER BOX NUMBER Nutech	Tm avg = 44.3 Vs = 32.67 V_{H_2O} = 104	after 36 min into inc fan slightly	NOZZLE AREA (A) .300 sq ft
Qw/Qm			Cp .84
Co	ran fan at slower rate than 1st	end 170.901	DRY GAS FRACTION (Fd) ~ .970 (est)

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H20) VAC	STACK TEMP (°F)	STACK TEMP (Ts) (°R)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP AVG (Tm) (°R)	GAS METER TEMP OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
10	0250	0.18 3	115		~~.165~~ .17	1.3	137.215	35	35.5	36	233	27
9	3	3	115		~~.175~~	~~1.34~~ 1.46		38	36.5	35	228	25
8	6	3	115		.195	1.50		40	38	36		
7	9	3	115		.195	1.50		43	40	37		
6	12	3	115		.205	1.58		43	40	37	236	26
5	15	3	115		.20	1.55		45	41.5	38	234	27
4	18	3	115		.18	1.40		46	42.5	39	238	
3	21	3	115		.17	1.32		47	43.5	40	240	25
2	24	3	115		.165	1.28		48	44	40	240	24
1	27	3	115		.15	1.17		48	44.5	41	241	24
10	0522 30	3	115		.17	1.32	153.406	47	44.5	42	244	23
9	3	4	115		.205	1.60		48	45	42	250	27
8	6	4	115		.225	1.76		50	46.5	43	251	28
7	9	4	115		.23	1.80		51	47.5	44		
6	12	4	109		.23	1.83		53	48.5	44	261	30
5	15	4	109		.23	1.83		53	49	45	268	32
4	18	4	109		.21	1.67		54	49.5	45	266	32
3	21	4	109		.19	1.51		54	49.5	45	~~266~~ 265	31
2	24	4	109		.17	1.35		53	49.5	46	264	32
1	27	4	109		.145	1.15		54	50.5	47	265	32
	30											

OEHL FORM MAY 78 18

AGAIN

PARTICULATE SAMPLING DATA SHEET

TOTAL WT = 0.0664 gr

RUN NUMBER	SCHEMATIC OF STACK CROSS SECTION	EQUATIONS	AMBIENT TEMP
B5R3 Scrub	3 min/pt	$°R = °F + 460$	°F
DATE: 11 mar 88	⊕ 3.2 pitot tube leak check ✓	$H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Cc}\right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$	STATION PRESS: 29 in Hg
PLANT: ~~Grissom~~ heat	⊖ 5.4 " " " "		HEATER BOX TEMP: °F
BASE: Grissom	soot blow ~ 25 min into run	PSTS = 10.9207	PROBE HEATER SETTING
SAMPLE BOX NUMBER: RAC	leak @ 6" Hg = zero leak	$\bar{Ts}$ = 109.6	PROBE LENGTH: 6' 9/035 in
METER BOX NUMBER: Nutech		$\bar{Tm}$ = 50.5	NOZZLE AREA (A): .300 sq ft
Qw/Qm		$\bar{\Delta H}$ = 1.67	Cp: .84
Co		TOT VOL = 36.106	DRY GAS FRACTION (Fd): ~8% (est)
		end 207.161	

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H2O)	STACK TEMP (°F)	STACK TEMP (Ts) (°R)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP AVG (Tm) (°R)	GAS METER TEMP OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
10	0915	~~.27~~ 4	110		.175	1.33	171.055	45		45	229	36
9	3	.18	115		~~.207~~ .21	1.64		47		45		
8	6	5	112		~~.205~~ .21	1.65		48		46	257	23
7	9	5	108		.21	1.67		50		46	265	24
6	12	5	103		.235	1.88		50		46		
5	15	5	101		.23	1.85		52		47	273	24
4	18	5	102		.195	1.57		52		47		
3	21	5	102		.21	1.70		52		47		
2	24	5	115		.205	1.61		52		47	265	18
1	27	5	104		.18	1.43		53		48	253	17
10	0950	5	115		~~.19~~ .20	1.58	189.0	52		49	257	24
9	3	5	106		.225	1.80		53		49		
8	6	5	111		.24	1.91		54		50	255	35
7	9	5	115		.23	1.87		56		50		
6	12	5.5	118		.24	1.89		56		51		
5	15	6	117		.235	1.85		56		50		
4	18	5.5	114		.225	1.78		56		50	253	41
3	21	5	110		.205	1.64		56		51	254	35
2	24	5	105		.18	1.45		57		51	254	33
1	27	4.5	103		.16	1.30		56		52	253	37
	30											

OEHL FORM MAY 78 18

PRELIMINARY SURVEY DATA SHEET NO. 2
(Velocity and Temperature Traverse)

BASE	DATE
6rr sS077	10 Mar 88

BOILER NUMBER: B5 Scrubber

INSIDE STACK DIAMETER: 60" Inches

STATION PRESSURE: 29.046 In Hg

STACK STATIC PRESSURE: 0.23 In H20

SAMPLING TEAM:

TRAVERSE POINT NUMBER	VELOCITY HEAD, V_p IN H20	cyclonic flow (deg)	STACK TEMPERATURE (°F)
10	~~0.26~~ 0.25	25	VEL 30 105
9	~~0.31~~ 0.285	10	32
8	~~0.32~~ 0.285	5	32
7	~~0.32~~ 0.295	0	32
6	0.295	10	32
5	0.30	0	33
4	0.275	10	31 105
3	0.20	8	27
2	0.185	5	26
1	0.17	2	25
		AVG = 7.5	AVG 30
⊕ pitot	5.5 ✓		
⊖ "	2.1 ✓		
act d = 0.3015			
.300			
.297			
.300			
AVERAGE			

OEHL FORM APR 78 16

PRELIMINARY SURVEY DATA SHEET NO. 2
(Velocity and Temperature Traverse)

BASE [illegible]	DATE [illegible]
BOILER NUMBER B5 SCRUBBER	
INSIDE STACK DIAMETER 60" Inches	
STATION PRESSURE 29.120 In Hg	
STACK STATIC PRESSURE 0.18 In H20	
SAMPLING TEAM	

TRAVERSE POINT NUMBER	VELOCITY HEAD, Vp IN H20	$\sqrt{V_p}$ DEG CLYCLCNK	STACK TEMPERATURE (°F)
1	0.13	4	115
2	0.16	6	
3	0.18	7	
4	0.185	9	
5	~~0.2~~ 195	0	
6	0.21	0	
7	0.205	5	
8	0.195	10	
9	0.195	10	
10	0.17	24	115
		AVG = 7.5	
	AVERAGE		

OEHL FORM APR 78 16

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE	DATE	RUN NUMBER
Grisson	10 Mar	BERI Scrubber #5

BUILDING NUMBER	SOURCE NUMBER
Boiler 5	

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER #5	0.3154	0.2864	0.0290
ACETONE WASHINGS (Probe, Front Half Filter) BEAKER # 16	98.7738	98.7333	0.0405
BACK HALF (If needed)			
	Total Weight of Particulates Collected		0.0695 gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H_2O)	150	100	50
IMPINGER 2 (H_2O)	120	100	20
IMPINGER 3 (Dry)	3.5	0	3.5
IMPINGER 4 (Silica Gel)	212.70	201.91	10.8
	Total Weight of Water Collected		84.3 gm

III. GASES (Dry)

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2	7.4	7.4	7.6		7.5
VOL % O_2	12.4	12.4	12.4		12.4
VOL % CO					
VOL % N_2					

Vol % N_2 = (100% - % CO_2 - % O_2 - % CO)

OEHL FORM MAY 78 20

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE	DATE	RUN NUMBER
Grissom	11 Mar 88	AGAIN B5R2 Scrub

BUILDING NUMBER	SOURCE NUMBER

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER 8	0.3248	0.2886	0.0362
ACETONE WASHINGS *(Probe, Front Half Filter)* BEAKER # 2F	100.3628	100.3376	0.0252
BACK HALF *(If needed)*			
	Total Weight of Particulates Collected		0.0614 gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 *(H20)*	176	100	76
IMPINGER 2 *(H20)*	118	100	18
IMPINGER 3 *(Dry)*	1.6	0	1.6
IMPINGER 4 *(Silica Gel)* 238.9 tare 27.6	211.3	202.80	8.50
	Total Weight of Water Collected		104.10 gm

III. GASES *(Dry)*

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2	8.8	8.9	8.9		8.9
VOL % O_2	10.6	10.5	10.5		10.5
VOL % CO					
VOL % N_2					

Vol % N_2 = (100% - % CO_2 - % O_2 - % CO)

OEHL FORM MAY 78 20

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE	DATE	RUN NUMBER
Grissom	11 Mar 88	again B5R3 Scrubber

BUILDING NUMBER	SOURCE NUMBER

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER 9	0.3332	0.2907	0.0425
ACETONE WASHINGS *(Probe, Front Half Filter)* BEAKER # 4F	98.4383	98.4144	0.0239
BACK HALF *(If needed)*			
	Total Weight of Particulates Collected		0.0664 gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 *(H20)*	174	100	74
IMPINGER 2 *(H20)*	119	100	19
IMPINGER 3 *(Dry)*	2.2	0	2.2
IMPINGER 4 *(Silica Gel)* 240.8 tare 27.6	213.2	203.28	9.9
	Total Weight of Water Collected		105.1 gm

III. GASES *(Dry)*

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2	10.0	10.0	10.0		10.0
VOL % O_2	9.6	9.7	9.8		9.7
VOL % CO					
VOL % N_2					

Vol % N_2 = (100% - % CO_2 - % O_2 - % CO)

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APPENDIX H

EPA Computer Program Emissions Calculations

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```
XROM "METH 5"
RUN NUMBER
B5 R1 BP
                RUN
METER BOX Y?
        1.0020  RUN
DELTA H?
        1.4100  RUN
BAR PRESS ?
       29.1800  RUN
METER VOL ?
       33.1960  RUN
MTR TEMP F?
       59.3000  RUN
% OTHER GAS
REMOVED BEFORE
DRY GAS METER ?
                RUN
STATIC HOH IN ?
         .0900  RUN
STACK TEMP.
      326.0000  RUN
ML. WATER ?
       47.0500  RUN
IMP. % HOH = 5.8

% HOH=5.8
% CO2?
       10.4000  RUN
% OXYGEN?
        8.9000  RUN
% CO ?
                RUN
MOL WT OTHER?
                RUN

MWd =30.02
MW WET=29.32
SQRT PSTS ?
        8.7994  RUN
TIME MIN ?
       60.0000  RUN
NOZZLE DIA ?
         .3740  RUN
STK DIA INCH ?
       66.0000  RUN

* VOL MTR STD = 35.753
  STK PRES ABS = 29.19
  VOL HOH GAS = 2.21
  % MOISTURE = 5.87
  MOL DRY GAS = 0.942
  % NITROGEN = 80.70
  MOL WT DRY = 30.02
  MOL WT WET = 29.32
  VELOCITY FPS = 21.60
  STACK AREA = 23.76
  STACK ACFM = 30.789.
* STACK DSCFM = 19.004.
  % ISOKINETIC =  97.71
```

```
XROM "METH 5"
RUN NUMBER
B5 R2 BP
                RUN
METER BOX Y?
        1.0020  RUN
DELTA H?
        1.6400  RUN
BAR PRESS ?
       28.9270  RUN
METER VOL ?
       35.6590  RUN
MTR TEMP F?
       49.4000  RUN
% OTHER GAS
REMOVED BEFORE
DRY GAS METER ?
                RUN
STATIC HOH IN ?
         .0900  RUN
STACK TEMP.
      325.0000  RUN
ML. WATER ?
       55.7000  RUN
IMP. % HOH = 6.3

% HOH=6.3

% CO2?
        9.9000  RUN
% OXYGEN?
        9.6000  RUN
% CO ?
                RUN
MOL WT OTHER?
                RUN

MWd =29.97
MW WET=29.21
SQRT PSTS ?
        9.5871  RUN
TIME MIN ?
       60.0000  RUN
NOZZLE DIA ?
         .3740  RUN
STK DIA INCH ?
       66.0000  RUN

* VOL MTR STD = 38.826
  STK PRES ABS = 28.93
  VOL HOH GAS = 2.62
  % MOISTURE = 6.33
  MOL DRY GAS = 0.937
  % NITROGEN = 80.50
  MOL WT DRY = 29.97
  MOL WT WET = 29.21
  VELOCITY FPS = 23.63
  STACK AREA   23.76
  STACK ACFM = 33.758.
* STACK DSCFM = 20.568.
  % ISOKINETIC =  98.03
```

```
XROM "METH 5"
RUN NUMBER
B5 R3 BP
                RUN
METER BOX Y?
        1.0020  RUN
DELTA H?
        1.5000  RUN
BAR PRESS ?
       28.9270  RUN
METER VOL ?
       33.9430  RUN
MTR TEMP F?
       51.6000  RUN
% OTHER GAS
REMOVED BEFORE
DRY GAS METER ?
                RUN
STATIC HOH IN ?
         .0900  RUN
STACK TEMP.
      322.0000  RUN
ML. WATER ?
       48.3500  RUN
IMP. % HOH = 5.8

% HOH=5.8
% CO2?
        9.4000  RUN
% OXYGEN?
        2.0000  CLX
       10.2000  RUN
% CO ?
                RUN
MOL WT OTHER?
                RUN

MWd =29.91
MW WET=29.22
SQRT PSTS ?
        9.1249  RUN
TIME MIN ?
       60.0000  RUN
NOZZLE DIA ?
         .3740  RUN
STK DIA INCH ?
       66.0000  RUN

* VOL MTR STD = 36.785
  STK PRES ABS = 28.93
  VOL HOH GAS = 2.28
  % MOISTURE = 5.83
  MOL DRY GAS = 0.942
  % NITROGEN = 80.40
  MOL WT DRY = 29.91
  MOL WT WET = 29.22
  VELOCITY FPS = 22.54
  STACK AREA = 23.76
  STACK ACFM = 32.126.
* STACK DSCFM = 19.754.
  % ISOKINETIC =  96.71
```

```
XROM "MASSFLO"

RUN NUMBER
B5 R1 BP
                RUN

VOL MTR STD ?
        35.753  RUN
STACK DSCFM ?
     19.004.00  RUN
FRONT 1/2 MG ?
        704.20  RUN
BACK 1/2 MG ?
                RUN

F  GR/DSCF = 0.30
F  MG/MMM = 695.55
F  LB/HR = 49.51
F  KG/HR = 22.46
```
→ 57.13 #/hr @ 12% CO_2

```
XROM "MASSFLO"

RUN NUMBER
B5 R2 BP
                RUN

VOL MTR STD ?
        38.826  RUN
STACK DSCFM ?
     20.568.00  RUN
FRONT 1/2 MG ?
        878.50  RUN
BACK 1/2 MG ?
                RUN

F  GR/DSCF = 0.35
F  MG/MMM = 799.04
F  LB/HR = 61.56
F  KG/HR = 27.92
```
→ 74.62 #/hr @ 12% CO_2

```
XROM "MASSFLO"

RUN NUMBER
B5 R3 BP
                RUN

VOL MTR STD ?
        36.785  RUN
STACK DSCFM ?
     19.754.00  RUN
FRONT 1/2 MG ?
      1.161.30  RUN
BACK 1/2 MG ?
          0.00  RUN

F  GR/DSCF = 0.49
F  MG/MMM = 1.114.86
F  LB/HR = 82.49
F  KG/HR = 37.42
```
→ 105.34 #/hr @ 12% CO_2

```
          XROM "METH 5"
RUN NUMBER
B5 R1 SC
                    RUN
METER BOX Y?
          1.0820    RUN
DELTA H?
          2.1200    RUN
BAR PRESS ?
         29.0460    RUN
METER VOL ?
         40.4550    RUN
MTR TEMP F?
         45.0000    RUN
STATIC HOH IN ?
           .2300    RUN
STACK TEMP.
        106.5000    RUN
ML. WATER ?
         84.3000    RUN


SAT % = 8.1


IMP. % HOH = 8.2

% HOH=8.1


% CO2?
          7.5000    RUN
% OXYGEN?
         12.4000    RUN
% CO ?
                    RUN

MWd =29.70
MW WET=28.75


SQRT PSTS ?
         12.2900    RUN
TIME MIN ?
         60.0000    RUN
NOZZLE DIA ?
           .3000    RUN
STK DIA INCH ?
         60.0000    RUN

* VOL MTR STD = 44.667
  STK PRES ABS = 29.06
  VOL HOH GAS = 3.97
  % MOISTURE = 8.05
  MOL DRY GAS = 0.919
  % NITROGEN = 80.10
  MOL WT DRY = 29.70
  MOL WT WET = 28.75
  VELOCITY FPS = 30.53
  STACK AREA = 19.63
  STACK ACFM = 35,967.
* STACK DSCFM = 29,941.
  % ISOKINETIC =  99.51
```

```
          XROM "METH 5"
RUN NUMBER
B5 R2 SC
                    RUN
METER BOX Y?  -
          1.0820    RUN
DELTA H?
          1.4900    RUN
BAR PRESS ?
         29.1200    RUN
METER VOL ?
         32.6900    RUN
MTR TEMP F?
         44.3000    RUN
STATIC HOH IN ?
           .1800    RUN
STACK TEMP.
        113.2000    RUN
ML. WATER ?
        104.1000    RUN


SAT % = 9.7


IMP. % HOH = 11.9

% HOH=9.7


% CO2?
          8.9000    RUN
% OXYGEN?
         10.5900    RUN
% CO ?
                    RUN

MWd =29.84
MW WET=28.69


SQRT PSTS ?
         10.4500    RUN
TIME MIN ?
         60.0000    RUN
NOZZLE DIA ?
           .3000    RUN
STK DIA INCH ?
         60.0000    RUN

* VOL MTR STD = 36.178
  STK PRES ABS = 29.13
  VOL HOH GAS = 4.90
  % MOISTURE = 9.75
  MOL DRY GAS = 0.903
  % NITROGEN = 80.60
  MOL WT DRY = 29.84
  MOL WT WET = 28.69
  VELOCITY FPS = 25.96
  STACK AREA = 19.63
  STACK ACFM = 30,580.
* STACK DSCFM = 24,755.
  % ISOKINETIC =  97.49
```

```
          XROM "METH 5"
RUN NUMBER
B5 R3 SC
                    RUN
METER BOX Y?
          1.0820    RUN
DELTA H?
          1.6700    RUN
BAR PRESS ?
         29.0000    RUN
METER VOL ?
         36.1060    RUN
MTR TEMP F?
         50.5000    RUN
STATIC HOH IN ?
           .1800    RUN
STACK TEMP.
        109.6000    RUN
ML. WATER ?
        105.1000    RUN


SAT % = 8.8


IMP. % HOH = 11.2

% HOH=8.8


% CO2?
         10.0000    RUN
% OXYGEN?
          9.7000    RUN
% CO ?
                    RUN

MWd =29.99
MW WET=28.93


SQRT PSTS ?
         10.9207    RUN
TIME MIN ?
         60.0000    RUN
NOZZLE DIA ?
           .3000    RUN
STK DIA INCH ?
         60.0000    RUN

* VOL MTR STD = 39.329
  STK PRES ABS = 29.01
  VOL HOH GAS = 4.95
  % MOISTURE = 8.83
  MOL DRY GAS = 0.912
  % NITROGEN = 80.30
  MOL WT DRY = 29.99
  MOL WT WET = 28.93
  VELOCITY FPS = 27.97
  STACK AREA = 19.63
  STACK ACFM = 31,890.
* STACK DSCFM = 26,135.
  % ISOKINETIC =  100.39
```

```
          XROM "MASSFLO"

RUN NUMBER
B5 R1 SC
                    RUN

VOL MTR STD ?
          44.667    RUN
STACK DSCFM ?
       29,941.00    RUN
FRONT 1/2 MG ?
           69.50    RUN
BACK 1/2 MG ?
                    RUN


F  GR/DSCF = 0.02
F  MG/MMM = 54.95
F  LB/HR = 6.16=7.9@12%CO2
F  KG/HR = 2.80

          XROM "MASSFLO"

RUN NUMBER
B5 R2 SC
                    RUN

VOL MTR STD ?
          36.178    RUN
STACK DSCFM ?
       24,755.00    RUN
FRONT 1/2 MG ?
           61.40    RUN
BACK 1/2 MG ?
                    RUN


F  GR/DSCF = 0.03
F  MG/MMM = 59.93
F  LB/HR = 5.56=7.5@12%CO2
F  KG/HR = 2.52
          XROM "MASSFLO"

RUN NUMBER
B5 R3 SC
                    RUN

VOL MTR STD ?
          39.329    RUN
STACK DSCFM ?
       26,135.00    RUN
FRONT 1/2 MG ?
           66.40    RUN
BACK 1/2 MG ?
                    RUN


F  GR/DSCF = 0.03
F  MG/MMM = 59.62
F  LB/HR = 5.84=7.0@12%CO2
F  KG/HR = 2.65
```

```
          XROM "METH 5"
RUN NUMBER
B3 R1 SC
                        RUN
METER BOX Y?
          1.0820        RUN
DELTA H?
          1.2300        RUN
BAR PRESS ?
         28.9330        RUN
METER VOL ?
         30.9220        RUN
MTR TEMP F?
         30.7000        RUN
STATIC HOH IN ?
           .0900        RUN
STACK TEMP.
        109.0000        RUN
ML. WATER ?
         70.5000        RUN

SAT % = 8.7

IMP. % HOH = 8.7

% HOH=8.7

% CO2?
          6.1000        RUN
% OXYGEN?
         13.5000        RUN
% CO ?
                        RUN

MWd =29.52
MW WET=28.52

SQRT PSTS ?
          9.5564        RUN
TIME MIN ?
         60.0000        RUN
NOZZLE DIA ?
           .3900        RUN
STK DIA INCH ?
         60.0000        RUN

• VOL MTR STD = 34.922
  STK PRES ABS = 28.94
  VOL HOH GAS = 3.32
  % MOISTURE = 8.68
  MOL DRY GAS = 0.912
  % NITROGEN = 80.40
  MOL WT DRY = 29.52
  MOL WT WET = 28.52
  VELOCITY FPS = 23.89
  STACK AREA = 19.63
  STACK ACFM = 28,143.
• STACK DSCFM = 23,069.
  % ISOKINETIC =  100.9
```

```
          XROM "METH 5"
RUN NUMBER
B3 R2 SC
                        RUN
METER BOX Y?
          1.0820        RUN
DELTA H?
          1.2600        RUN
BAR PRESS ?
         28.9330        RUN
METER VOL ?
         31.4100        RUN
MTR TEMP F?
         37.0000        RUN
STATIC HOH IN ?
           .0900        RUN
STACK TEMP.
        105.3000        RUN
ML. WATER ?
        107.1000        RUN

SAT % = 7.8

IMP. % HOH = 12.6

% HOH=7.8

% CO2?
          6.0000        RUN
% OXYGEN?
         14.0000        RUN
% CO ?
                        RUN

MWd =29.52
MW WET=28.62

SQRT PSTS ?
          9.5161        RUN
TIME MIN ?
         60.0000        RUN
NOZZLE DIA ?
           .3000        RUN
STK DIA INCH ?
         60.0000        RUN

• VOL MTR STD = 35.026
  STK PRES ABS = 28.94
  VOL HOH GAS = 5.04
  % MOISTURE = 7.81
  MOL DRY GAS = 0.922
  % NITROGEN = 80.00
  MOL WT DRY = 29.52
  MOL WT WET = 28.62
  VELOCITY FPS = 23.74
  STACK AREA = 19.63
  STACK ACFM = 27,974.
• STACK DSCFM = 23,299.
  % ISOKINETIC =  100.20
```

```
          XROM "METH 5"
RUN NUMBER
B3 R3 SC
                        RUN
METER BOX Y?
          1.0820        RUN
DELTA H?
          1.2900        RUN
BAR PRESS ?
         28.9330        RUN
METER VOL ?
         31.8280        RUN
MTR TEMP F?
         38.6000        RUN
STATIC HOH IN ?
           .0900        RUN
STACK TEMP.
        105.0000        RUN
ML. WATER ?
        100.3000        RUN

SAT % = 7.7

IMP. % HOH = 11.8

% HOH=7.7

% CO2?
          6.1000        RUN
% OXYGEN?
         14.3000        RUN
% CO ?
                        RUN

MWd =29.55
MW WET=28.65

SQRT PSTS ?
         10.3480        RUN
TIME MIN ?
         60.0000        RUN
NOZZLE DIA ?
           .3000        RUN
STK DIA INCH ?
         60.0000        RUN

• VOL MTR STD = 35.381
  STK PRES ABS = 28.94
  VOL HOH GAS = 4.72
  % MOISTURE = 7.74
  MOL DRY GAS = 0.923
  % NITROGEN = 79.60
  MOL WT DRY = 29.55
  MOL WT WET = 28.65
  VELOCITY FPS = 25.81
  STACK AREA = 19.63
  STACK ACFM = 30,401.
• STACK DSCFM = 25,353.
  % ISOKINETIC =  93.80
```

```
          XROM "MASSFLO"

RUN NUMBER
B3 R1 SC
                        RUN

VOL MTR STD ?
          34.922        RUN
STACK DSCFM ?
       23,068.00        RUN
FRONT 1/2 MG ?
          114.00        RUN
BACK 1/2 MG ?
                        RUN

F  GR/DSCF = 0.05
F  MG/MMM = 115.28
F  LB/HR = 9.96
F  KG/HR = 4.52
```

19.6 #/hr @ 12% CO_2

```
          XROM "MASSFLO"

RUN NUMBER
B3 R2 SC
                        RUN

VOL MTR STD ?
          35.026        RUN
STACK DSCFM ?
       23,299.00        RUN
FRONT 1/2 MG ?
           52.50        RUN
BACK 1/2 MG ?
                        RUN

F  GR/DSCF = 0.02
F  MG/MMM = 52.93
F  LB/HR = 4.62
F  KG/HR = 2.10
```

9.2 #/hr @ 12% CO_2

```
          XROM "MASSFLO"

RUN NUMBER
B3 R3 SC
                        RUN

VOL MTR STD ?
          35.381        RUN
STACK DSCFM ?
       25,353.00        RUN
FRONT 1/2 MG ?
          127.80        RUN
BACK 1/2 MG ?
                        RUN

F  GR/DSCF = 0.06
F  MG/MMM = 127.56
F  LB/HR = 12.11
F  KG/HR = 5.49
```

23.8 #/hr @ 12% CO_2

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APPENDIX I
Calibration Data

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METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Date 28 Oct 87 Meter box number Nutech

Barometric pressure, P_b = 29.575 in. Hg Calibrated by Daly

VAC	Orifice manometer setting (ΔH), in. H_2O	Gas volume: Wet test meter (V_w), ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperature: Wet test meter (t_w), °F/R	Temperature: Dry gas meter: Inlet (t_{d_i}), °F	Temperature: Dry gas meter: Outlet (t_{d_o}), °F	Temperature: Dry gas meter: Avg[a] (t_d), °R	Time (θ), min	Y_i	$\Delta H@_i$ in. H_2O
6	0.5	5	4.672	74 74 534	79 75	79 75	535.5	13 25/60	1.072	2.056
6	1.0	5	4.684	73 74 533.5	85 81	75 81	540	9 33/60	1.078	2.096
6	1.5	10	9.376	73 74 533.5	90 86	90 86	543.75	15 40/60	1.083	2.067
6	2.0	10	9.400	73 73 533	93 91	93 91	547	13 49/60	1.086	2.126
6	3.0	10	9.441	73 73 533	97 95	97 95	550.5	11 19/60	1.086	2.126
6	4.0	10	9.433	74 73 533.5	99 98	88 87	553	9 55/60	1.088	2.171
								Avg	1.082	2.11

ΔH, in. H_2O	$\frac{\Delta H}{13.6}$	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d \left(P_b + \frac{\Delta H}{13.6}\right)(t + 460)}$	$\Delta H@_i = \frac{0.0317\ \Delta H}{P_b\ (t_d + 460)} \left[\frac{(t_w + 460)\ \Theta}{V_w}\right]^2$
0.5	0.0368		
1.0	0.0737		
1.5	0.110		
2.0	0.147		
3.0	0.221		
4.0	0.294		

[a] If there is only one thermometer on the dry gas meter, record the temperature under t_d.

POSTTEST DRY GAS METER CALIBRATION DATA FORM (English units)

Test number POST Date 12 APR 88 Meter box number NUTECH Plant McCLELLAN AFB

Barometric pressure, P_b = 29.740 in. Hg Dry gas meter number 6840593 Pretest Y 1.082

VAC "Hg	Orifice manometer setting, (ΔH), in. H_2O	Gas volume: Wet test meter (V_w), ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperature: Wet test meter (t_w), °F/°R	Temperature: Dry gas meter: Inlet (t_{d_i}), °F	Temperature: Dry gas meter: Outlet (t_{d_o}), °F	Temperature: Dry gas meter: Average[a] (t_d), °F/°R	Time (Θ), min	Vacuum setting, in. Hg	Y_i	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d \left(P_b + \frac{\Delta H}{13.6}\right)(t_w + 460)}$
7.5	1.5	10	9.725	76 77 76.5/536.5	84 93 88.5	80 85 82.5	85.5/545.5	22 59/60	7.5	1.094	
7.5	1.5	10	9.310	77 78 77.5/537.5	93 97 95	86 80 83	[illegible]/531.5	17 57/60	7.5	1.088	
7.5	1.5	10	9.350	73 75 74/539	[illegible] 93	[illegible] 91	[illegible]/534.5	16 43/60	7.5	1.093	
										Y = 1.095	OK

[a] If there is only one thermometer on the dry gas meter, record the temperature under t_d

where

V_w = Gas volume passing through the wet test meter, ft^3.

V_d = Gas volume passing through the dry gas meter, ft^3.

t_w = Temperature of the gas in the wet test meter, °F.

t_{d_i} = Temperature of the inlet gas of the dry gas meter, °F.

t_{d_o} = Temperature of the outlet gas of the dry gas meter, °F.

t_d = Average temperature of the gas in the dry gas meter, obtained by the average of t_{d_i} and t_{d_o}, °F.

ΔH = Pressure differential across orifice, in. H_2O.

Y_i = Ratio of accuracy of wet test meter to dry gas meter for each run.

Y = Average ratio of accuracy of wet test meter to dry gas meter for all three runs; tolerance = pretest Y ± 0.05Y.

P_b = Barometric pressure, in. Hg.

Θ = Time of calibration run, min.

$\bar{Y}$ TOLERANCE = PRETEST Y ± 0.05Y

= 1.035 → 1.136

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NOZZLE CALIBRATION DATA FORM

Wright Patterson

Date ~~Dec 85~~ 8 MAR 88 Calibrated by GARRISON

Nozzle identification number	Nozzle Diameter[a]			ΔD,[b] mm (in.)	D_{avg}[c]
	D_1, mm (in.)	D_2, mm (in.)	D_3, mm (in.)		
0.375	0.375	0.374	0.374	0.001	0.374

where:

[a] $D_{1,2,3,}$ = three different nozzles diameters, mm (in.); each diameter must be within (0.025 mm) 0.001 in.

[b] ΔD = maximum difference between any two diameters, mm (in.), $\Delta D \leq$(0.10 mm) 0.004 in.

[c] D_{avg} = average of D_1, D_2, and D_3.

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NOZZLE CALIBRATION DATA FORM

Wright Patterson

Date ~~Dec 85~~ 10 MAR 88 Calibrated by GARRISON

Nozzle identification number	Nozzle Diameter[a]			ΔD,[b] mm (in.)	D_{avg}[c]
	D_1, mm (in.)	D_2, mm (in.)	D_3, mm (in.)		
0.3	0.300	0.299	0.300	0.001	0.300

where:

[a] $D_{1,2,3}$, = three different nozzles diameters, mm (in.); each diameter must be within (0.025 mm) 0.001 in.

[b] ΔD = maximum difference between any two diameters, mm (in.), $\Delta D \leq$(0.10 mm) 0.004 in.

[c] D_{avg} = average of D_1, D_2, and D_3.

ANALYTICAL BALANCE CALIBRATION FORM

Balance name ______________________ Number __________

Classification of standard weights ______________________

Date	0.500 g	1.0000 g	10.0000 g	50.0000 g	100.0000 g	Analyst
Sartorius ID# FH4314/F7821	0.51	1.01	9.97	50.00	~~99.63~~ ~~99.58~~ 99.82	TMD 4 mar 88
Mettler AE163	0.4999	1.0000	9.9996	49.9979	99.9963	TMD 4 mar 88
Mettler AE163		1.000				TMD 5 Mar 88
Ohaus (Triple Beam	0.50	0.95	10.00	~~50.00~~ 50.10	100.05	8 Mar 88 TMD
						9 Mar TMD
Ohaus	0.50					13 Mar TMD
[illegible]	0.30 0.5[illegible]					11 Mar TMD
METTLER 163	0.4999	1.000	9.9997	49.9980	99.9965	21 MAR 88

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ANALYTICAL BALANCE CALIBRATION FORM

Balance name ______________________ Number ____________

Classification of standard weights ______________________

Date	0.500 g	1.0000 g	10.0000 g	50.0000 g	100.0000 g	Analyst
Sartorius 1702MP8	0.4999	0.9999	10.0001	50.0008	100.0022	TW 17 Mar 88
ID# FH3029	0.4999	1.0000	10.0000	50.0001	100.0009	TW

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